Clinical Practice Guidelines for the Prevention and Management of Diabetes Foot Complications

Saskatchewan
Ministry of
Health

February 6, 2008

Table of Contents

Introduction 5

Preface 9

Prevention and Education 11

Screening (Diabetic Foot Risk Assessment) 15

Assessment of the Diabetic Foot 17

Management of Diabetic Foot Complications other than Ulceration 21

Management of Diabetic Foot Complication with Ulceration 29

Continuity of Care 37

Recommendations for Health Care Organizations 39

Appendices 41

(1) Interdisciplinary Approach to Prevention and Management of Diabetic Foot Complications

(2) Diabetes Foot Screen

(3) Referral Template

(4) Saskatchewan Health Diabetes Foot Brochure Information

(5) Sample Wound Classification Tool

(6) General Wound Healing Information

(7) General Infection and Prevention and Control Information

(8) Genral Information for Diabetic Foot Ulcer Dressing Choices

(9) Staying Healthy with Diabetes

(10) Glossary

(11) References

INTRODUCTION

Diabetes is a serious health problem that affects a growing number of Canadians. The population is aging, physical activity is decreasing, rates of obesity are rising, and all are contributing to the prevalence of this chronic condition.

Diabetes is caused by both hereditary and environmental factors. The rate of diabetes has been increasing steadily in Canada over the past decade. Close to 5% (1.3 million people) of Canadians aged 12 and older reported having diabetes in 2005, compared to 3% a decade ago, in 1994/95.[1]

In Saskatchewan, the diabetes prevalence rate also continues to increase steadily each year. Provincial rates have risen from 29.2 persons per thousand in 1996/1997 to 52.0 persons per thousand in 2004/2005. (Note: Increase is not based solely on prevalence, but also on methodology changes in surveillance.) Trends indicate approximately 4,500 - 5,000 new incidents of diabetes in Saskatchewan each year. Data indicates that in 2004/05, there were approximately 59,000 persons diagnosed and living with diabetes in Saskatchewan. Added to this are an unknown number of persons with undiagnosed diabetes. The prevalence of diabetes and the many costly and complex complications associated with it affect how this chronic condition is managed and have wide spread effects in human, economic and social terms.

Though many serious and costly complications affect individuals with diabetes, such as heart disease, kidney failure and blindness, foot complications take the greatest toll. The diabetic foot is a significant economic problem, especially if amputation results in prolonged hospitalization and rehabilitation. The corresponding cost for the individual include costs associated with cost of care and supplies, indirect costs due to loss of productivity, and loss of quality of life.

Although amputation procedures also occur in persons without diabetes, data analysis shows that the amputation rates for persons with diabetes are much higher than the amputation rate for persons without diabetes as shown below:

Amputation Rates for Individuals in Saskatchewan with and without Diabetes, 2004/2005*

	People with Diabetes		People without Diabetes		Total	
Amputation Procedure	Number of People	People per 100,000 population with Diabetes	Number of People	People per 100,000 population without diabetes	Number of People	People per 100,000 population
Amputation - above knee	62	105.4	34	3.5	96	9.2
Amputation - below knee	72	122.4	18	1.8	90	8.6
Amputation - foot	88	149.6	19	1.9	107	10.2
Amputation - toe(s)	51	86.7	49	5.0	100	9.6

*Rates were determined using the hospital separations and physician services health records

Source: Population Health Branch, EREU

Most amputations relating to diabetes begin with a foot ulcer. Diabetic foot ulcers as a result of neuropathy or ischemia are common. In developed countries, up to 5% of people with diabetes have foot ulcers, and one in every six people with diabetes will have an ulcer during their lifetime.[2] Foot problems are the most common cause of admission to hospital for people with diabetes.

In most cases, diabetic foot ulcers and amputations can be prevented. A substantial number of studies have indicated that 85% of all diabetes-related lower extremity amputations are preceded by a foot ulcer, and that amputation rates can be reduced by more than 50% with an interdisciplinary team approach (see Appendix 1 for example of interdisciplinary team members), good diabetes control and well informed self care.[2] There is strong evidence to indicate that foot care is best delivered when it is provided by an interdisciplinary team. This should closely involve the person with diabetes and his or her family, along with health care professionals from different specialties. The prevention and treatment of diabetic foot problems includes the following:

- Annual inspection of the foot
- Identification of the foot at risk
- Education of people with diabetes and healthcare professionals
- Appropriate footwear
- Rapid treatment of all foot problems

Only through an interdisciplinary team approach, addressing the diversity of possible foot problems in people with diabetes, can the desired reduction in amputation rates be achieved.

BACKGROUND

Saskatchewan Health, podiatric staff from Saskatchewan Regional Health Authorities and the Saskatchewan Institute of Applied Science and Technology (SIAST) Nursing Division recently published "Risk Identification of the Foot in Diabetes." [3] This publication was distributed to all Health Regions for the purpose of teaching health professionals how to assess and categorize risks of the foot for people with diabetes.

In 2004, Saskatchewan Health provided funding for development and implementation of a diabetes foot program. Specifically, Saskatchewan Health requested that the following be developed:

- A standardized interdisiplinary strategy of evaluating wounds;
- Standardized guidelines for effective treatment of the diabetic foot;
- Decision-making tools for clinicians to manage core aspects of foot care in persons with diabetes;
- Evidence based tools that support clinical decision-making; and
- A template for local adaptation and implementation of a structured system of diabetes foot care

A small working group listed on page 6 comprised of podiatrists, diabetes educators, wound care nurses, family physicians, vascular surgeon, home care personnel and the Provincial Diabetes Coordinator of Saskatchewan Health was convened in November 2005. The previous work pertaining to the management of diabetic foot ulcers undertaken by the Saskatoon and Regina Qu'Appelle Health Regions, and the wound care guidelines developed by the Saskatchewan Health Quality Council, were utilized in the development of "The Clinical Practice Guidelines for the Prevention and Management of Diabetes Foot Complications".

These clinical practice guidelines are developed from the references listed in Appendix 11. They are intended to provide evidence-based guidance for general patterns of practice and not to necessarily dictate the care of a particular patient. Although the intent of the guideline developers is to be as comprehensive as possible, they realize that it is, in fact, a work in progress and will require future modification as new knowledge becomes available.

These guidelines are intended for use by all health care professionals for the adult population with diabetes. An interdisciplinary approach should be used for the prevention and management of diabetes foot complications. It is recognized that each health care professional brings a different level of knowledge/expertise to this area.

The goals of this document are to introduce a common vocabulary and consistency of practice for using current evidence and best practice standards found in the literature. This document is meant to assist health professionals in teaching people with diabetes self-care concepts and techniques. These guidelines include: an outline of normal wound healing, possible impediments to the process, and some guidelines for dressing selection; information required for the prevention of diabetic foot complications; materials for use in teaching individuals and their families about diabetic foot

ulcer/wound management specifics. There is also a series of appendices that contain educational materials for health care providers and for people living with diabetes.

Educational sessions facilitating the implementation of these clinical practice guidelines are recommended. The Diabetes Foot Working Group is currently developing an implementation strategy for these sessions.

Members of the Working Group for the "Clinical Practice Guidelines for the Prevention and Management of Diabetes Foot Complications":

Sheilla Achilles - Saskatoon Regional Health Authority
Karen Butler - Regina Qu'Appelle Regional Health Authority
Dr. Jerry Danielson - Regina Qu'Appelle Regional Health Authority
Catherine Delaney - Saskatchewan Health Quality Council
Betty Lou Fagnou - Kelsey Trail Regional Health Authority
Donna Flahr - Saskatoon Regional Health Authority
Kate Foster - Saskatoon Regional Health Authority
Laurie Gander - Saskatchewan Health Quality Council
Sandy Hassler - File Hills Home Care
Laurie Ironstand - Battlefords Tribal Council Indian Health Services
Dr. Hugh Juma - Saskatoon Regional Health Authority
Beverley Kernohan - Heartland Regional Health Authority
Dr. Tessa Laubscher - University of Saskatchewan, Saskatoon Regional Health Authority
Linda Law - Five Hills Regional Health Authority
Dianne Mooney - Regina Qu'Appelle Regional Health Authority
Myra Parcher - Saskatoon Regional Health Authority
Brenda Robinson - Regina Qu'Appelle Regional Health Authority
Marci Scott - Regina Qu'Appelle Regional Health Authority
Dr. Jodi Spelay - Saskatoon Regional Health Authority
Dr. Ata Stationwala - Five Hills Regional Health Authority
Yvette Sunchild - Saskatchewan First Nations and Inuit Health
Jane Wilmot - Regina Qu'Appelle Regional Health Authority
Dale Young - Regina Qu'Appelle Regional Health Authority
Marlene Chapellaz - Saskatchewan Ministry of Health

Diabetic Foot Complications

Preface

Foot ulcers develop in approximately 15% of individuals with diabetes and foot disorders are a leading cause of hospitalization among this group.[4] Eighty-five percent of lower limb amputations in persons with diabetes are preceded by foot ulcers, indicating that foot ulcer prevention and management are of paramount importance.[4] The most important factors related to the development of foot ulcers are peripheral neuropathy, minor foot trauma and foot deformities. Diabetic foot ulcers are complex and multi-factorial in nature, often involving ischemic and neuropathic components, the latter of these two occurring within 10-15 years of diagnosis in 50% of diabetic patients.[5]

Entirely ischemic ulcers are relatively uncommon, occurring in only about 10-15% of the diabetic population with foot ulcers. Atherosclerotic disease is 20 times more common in the lower limbs of patients with diabetes compared with age and sex matched controls[6]. Trauma to the lower limb in diabetics with ischemic disease can often initiate a cascade of ulceration and amputation; the most common cause of initial injury is inappropriate footwear.[4]

Neuropathy is a common component of ulceration and will be discussed as three categories; motor, autonomic and sensory.

Peripheral motor neuropathy is highlighted by a change in joint mobility and a loss of tone in intrinsic foot muscles. Changes to the musculature of the foot result in hammer toes, hallux valgus and callus production.[7] A reduction in ankle and toe joint mobility related to glycosolation of collagen within the joint structure alters pressure on the plantar surface of the foot[5] and increases the likelihood of tissue breakdown.

Peripheral autonomic neuropathy causes the formation of arteriovenous shunting. Shunt formation results in the inhibition of temperature regulation to the foot and is demonstrated by a warm foot with bounding pulses. These foot tissues have a reduced ability to sweat resulting in dry skin, skin cracks and fissures.[5] Openings in the skin can be a portal for bacterial invasion and, if unnoticed because of sensory loss, can result in ulceration.

Peripheral sensory neuropathy is the most commonly recognized etiology of foot ulceration; approximately 80% of diabetic patients with ulceration have peripheral sensory neuropathy. [5] This loss of protective sensation, as a result of large and small nerve fiber damage[7] puts the individual with diabetes at risk of unnoticed injury, resulting in an increased likelihood of ulceration and possibly unrecognized infection. The identification of sensory changes in the diabetic lower limb is easily accomplished by the use of a 5.07 Semmes-Weinstein monofilament to the plantar foot surface in several locations [8](see Appendix 2 for sample diabetes foot screen form and instructions for screening process).

In summary, structural changes resulting from peripheral neuropathy alter the pressure to the walking surface of the foot. Tissues are less able to tolerate the increased plantar pressures as a result of decreased elasticity because of tissue glycosolation. Lack of protective sensation leads to a lack of awareness on the part of the individual and the person continues to ambulate. Repetitive high pressures to the sole of the foot as a result of walking, cause callus formation, and tissue breakdown at these pressure points can result in hemorrhage and ulceration. Foot complications in people with diabetes can be reduced by preventative measures like good glucose control, diabetes education and self-management, not smoking, sensation testing, appropriately fitted foot wear, routine foot examination and professional nail and callus care.

PREVENTION AND EDUCATION

The prevention of diabetic foot complications requires a proactive approach involving the person with diabetes, family/care givers and an interdisciplinary team of health care providers. Education is an essential element in the empowerment of people with diabetes, helping to develop an effective partnership between healthcare professionals and the individual, which is key to achieving effective care. Optimal diabetes management, daily foot care, education for the person with diabetes and their family, along with screening and risk assessment by trained care providers are all critical aspects for prevention of diabetic foot complications.

Prevention of diabetic foot complications has the following requirements:

1. **Optimal diabetes management**
   Prevention needs good overall diabetes management as well as specific foot care. Preventive education and care should include referral to a Regional Diabetes Education service (Referral Template Appendix 3) as well as the following components:
   - Optimal glycemic control
   - Control of hyperlipidemia
   - Control of hypertension
   - Treatment of renal disease
   - Treatment of peripheral vascular disease
   - Optimal nutritional status
   - Smoking cessation
   - Identification and management of:
     - Neuropathy
     - Retinopathy

   For further information regarding diabetes management, see the Canadian Diabetes Association 2008 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. [9] See www.diabetes.ca

2. **Patient self management of the feet**
   Basic foot care should be considered an important part of self-care in people with diabetes, and as much part of a self-care routine as blood glucose control or meal planning.

3. **Patient and family education**
   Education about foot care should be provided to all people with diabetes and their families/caregivers. Patient education should be tailored to meet each individual's needs and risk factors, using the principles of adult education. Education should be provided in several sessions over time, using a variety of teaching methods. It is essential to evaluate whether the patient has understood the message, is motivated to act and has sufficient self-care skills.

A person with diabetes should expect to be offered information about the following:

- Self-care and monitoring of diabetes
- The potential impact of diabetes on the feet
- Daily examination of feet for problems and when to seek advice from a healthcare professional e.g. if any color change, swelling, breaks in the skin, pain or numbness is found, or if self-care and monitoring is not possible or difficult
- Implications of loss of protective sensation
- Possible consequences of neglecting the feet
- Methods to help self-examination/monitoring (for example, the use of mirrors if mobility is limited
- Hygiene (daily washing and careful drying)
- Skin care (moisturizer use)
- Nail care
- Dangers associated with inappropriate mechanical and chemical skin removal
- Footwear (the importance of well fitting shoes and hosiery)
- Injury prevention and the importance of not walking barefoot when reduced sensation is present
- Annual foot exam by trained professional to assess for neuropathy and vascular disease
- Prompt detection and management of any problems are important, thus the importance of seeking help as soon as possible

Note: A client brochure ***"Why People With Diabetes Need To Take Care Of Their Feet"*** has been developed for use as a teaching tool and client information. Additional information is provided in Appendix 4.

4. **Management of non ulcerative pathology**

   All persons living with diabetes shou'd have access to health care providers to help them (as needed) with the following:

   - Foot inspection/examination and risk assessment
   - Nail care
   - Callus care
   - Skin care
   - Foot hygiene
   - Podiatric management
   - Pressure reduction to foot (off-loading)
   - Appropriate selection of protective footwear which includes:
     - commercially available shoes with proper design characteristics may be adequate for low-risk patients
     - added depth shoes should be recommended for high-risk patients who have sensory loss, vascular insufficiency and/or mild to moderate foot deformity (a custom molded inlay may be added to these shoes to further enhance pressure distribution)
     - custom molded shoes with custom inlays should be recommended for high-risk patients with advanced deformity

Did You Know?
The first level of prevention is to have persons with diabetes remove their socks and shoes for a visual inspection by a health care practitioner.

5. **Interdisciplinary approach**
   Effective care involves a partnership between the individual with diabetes and health care providers. All decision-making should be shared. The maintenance of foot health in the person with diabetes is best achieved by a consistent, preventative strategy that is implemented with an interdisciplinary approach involving a team of specialists and personnel who provide a coordinated process of care.

6. **Appropriate footwear**
   Inappropriate footwear is a major cause of ulceration. Appropriate footwear (adapted to the altered biomechanics and deformities) is essential for prevention. Individuals without loss of protective sensation can select off-the-shelf footwear by themselves. Individuals, who have neuropathy and or ischemia, must take extra care with the fitting of footwear, especially when foot deformities are present.

7. **Other issues that influence diabetes management and the prevention of complications associated with diabetes:**
   - Other chronic conditions
   - Financial resources/support
   - Emotional support
   - Educational level
   - Literacy level
   - Cultural and spiritual background
   - Service access
   - Social support

   An effective prevention and management strategy must address these issues for each individual and their family.

SCREENING (DIABETIC FOOT RISK ASSESSMENT)

A physical examination of the feet should be performed by a health care professional to assess risk factors for ulceration/amputation.

- A physical examination of the feet should be performed by a health care professional at least annually in all people with diabetes. Foot examinations should be performed at more frequent intervals in individuals at high risk for vascular and neuropathic complications of diabetes.[9]
- The physical examination of the feet includes assessment of the blood circulation and the sensation in the foot, and examination for any skin changes (e.g. ulceration) and structural deformities of the foot.[9]
- A diabetes foot screen should be completed in order to assess the diabetic foot and assign a risk category. (See Appendix 2 for sample foot screening form and instructions, including filament application instructions.)

The foot screen should result in an assignment to a Risk Category based on the above diabetes foot screening process and the Louisiana State University Health Sciences Centre (LSUHC) Comprehensive Risk and Management Categories for the Feet. This is depicted on the following page. Note: Any risk category greater than 0 should be referred to a primary care provider (e.g. family physician, nurse practitioner, diabetes educator). (See Referral template Appendix 3).

Comprehensive Diabetes Lower Extremity Amputation Prevention Program
Risk and Management Categories For the Feet

Determine risk category & appropriate management based on the following table:

Risk Category	Description	Actions to be taken
0	No loss of protective sensation (LOPS) in feet Note: LOPS is assessed using a 5.07 monofilament (10 gram) at multiple locations on each foot (see Appendix 2)	• Education emphasizing disease control, proper shoe fit and design • Follow up annually for foot screen • Follow as needed for skin/callus/ nail care or orthoses
1	Loss of protective sensation in feet	• Education emphasizing disease control; proper shoe fit/design; daily self-inspection; skin/nail care; early reporting of foot injuries • Routine follow up 3-6 months for foot/shoe examination and nail care
2	Loss of sensation in feet with high pressure (callus/deformity) or poor circulation	• Education emphasizing disease control, proper shoe fit/design, daily self-inspection, skin/nail care, early reporting of foot injuries • Depth-inlay footwear, molded/modified orthoses, modified shoes as needed • Routine follow up 1-3 months for foot/activity/footwear evaluation and callus/nail care
3	History of plantar ulceration or neuropathic fracture (Charcot foot)	• Education emphasizing disease control, proper shoe fit/design, daily self-inspection, skin/nail care, early reporting of foot injuries • Depth-inlay footwear, molded/modified orthoses, modified shoes as needed • Routine follow up 1-12 weeks for foot/activity/footwear evaluation and callus/nail care

ASSESSMENT OF THE DIABETIC FOOT

Should be performed by a trained professional such as physician, podiatrist, or wound care specialist.

1. **Conduct A History**
    - Age
    - Chief concern
    - Present illness
    - Allergies
    - Co-morbidities
    - Medications
    - Previous surgeries (focus on the lower limb)
    - Wound problems
    - Infection or ulceration
    - Previous amputation
    - Glycemic control
    - Nutrition
    - Occupation
    - Lifestyle such as alcohol, tobacco, activity level
    - Mechanism of injury

2. **Conduct A Physical Exam Of The Lower Limb** including muscoskeletal, skin, neurologic and vascular:

    a) **Musculoskeletal Examination**
    - Biomechanical abnormalities:
        - Orthopedic abnormalities:
            - Hammer toes
            - Bunion(s) or Tailor's bunion(s)
            - Flat or high-arched feet
            - Charcot deformities
            - Latrogenic deformities (e.g., amputations)
        - Limited joint mobility
        - Tendo-achilles contractures/equinus
    - Gait evaluation:
        - Rearfoot position
        - Forefoot to rearfoot relationship
        - Femoral range of motion
        - Knee position
        - Tibial angle (torsion)
        - Leg length discrepancies
        - Angle of gait
    - Muscle group strength testing:
        - Passive and active, non-weightbearing and weightbearing
        - Foot drop
        - Atrophy- intrinsic muscle atrophy

- Plantar pressure assessment
  - Computerized devices
  - Harris ink mat

b) Vascular Examination

- Palpation of pulses (e.g. dorsalis pedis, posterior tibial, popliteal, femoral)
- Capillary refill time (normal ≤ 3 seconds)
- Venous filling time (normal ≤ 20 seconds)
- Colour changes:
  - Cyanosis
  - Dependant rubor
  - Erythema
- Presence of edema
- Temperature gradient
- Dermal thermometry
- Integumental changes consistent with ischemia:
  - Skin atrophy
  - Nail atrophy
  - Abnormal wrinkling
  - Diminished pedal hair

c) Neurologic Examination

- Vibration perception: tuning fork 128 Hz (cps); measurement of vibration perception threshold (Biothesiometer)
- Light pressure: Semmes-Weinstein (5.07 gauge) 10-gram monofilament
- Light touch: cotton wool
- Two-point discrimination
- Pain: pinprick
- Temperature perception: hot and cold
- Deep tendon reflexes: ankle, knee
- Babinski test
- Rhomberg's test

d) Dermatologic Examination

- Skin appearance:
  - Colour, texture, turgor, quality
  - Dry skin
- Calluses:
  - Discoloration
  - Subcallus hemorrhage
- Fissures (especially posterior heels)
- Nail appearance:
  - Onychomycosis
  - Dystrophic
  - Atrophic
  - Hypertrophic
  - Paronychia
- Presence of hair

- Ulceration, gangrene, infection (note location, size, depth, infection status, etc.)
- Interdigital lesions
- Tinea pedis
- Markers of diabetes:
  - Shin spots- diabetic dermopathy
  - Necrobiosis lipoidica diabeticorum
  - Bullosum diabeticorum
  - Granuloma annulare

e) Wound Description

- Wound location
- Wound dimensions including depth
- Quality of the wound bed
- Describe wound edges including undermining/tracking
- Edema
- Exudate, type, amount, odor, colour
- Presence of necrosis
- Surrounding erythema/cellulitis
- Mechanism of injury (history)
- Penetration to deep structures
- Signs of infection
- Sinus tracking
- Induration

Classify wound according to a recognized wound classificiation system examples: University of Texas Foot Wound Classification System or Wagner Ulcer Classification Tool (Appendix 5).

Provider should identify which classification tool is being used.

3. **Assess For Ischemia**
   - Non-invasive vascular testing (i.e., toe brachial pressure index, pulse palpation, capillary refill)
   - Vascular lab studies[10]

4. **Examine Footwear**
   - Type of shoes
   - Fit of shoes
   - Patterns of wear on the lining and sole of the shoes
   - Presence of foreign bodies in shoes
   - Insoles, orthoses

MANAGEMENT OF DIABETIC FOOT COMPLICATIONS OTHER THAN ULCERATION

1. Diabetic Distal Symmetric Polyneuropathy (DPN)

Etiology
DPN is a chronic sensory and motor neuropathy involving the distal extremities, usually commonly the lower limbs. It is the most common type of nerve damage seen in people with diabetes. DPN is associated with the following risk factors: duration of diabetes, poor glycemic control, high blood pressure, and hyperlipidemia.

Patients with DPN may experience symptoms such as neuropathic pain (burning, stabbing or aching pain, paresthesias, hyperasthesias) or numb feet. Neuropathic pain tends to be worse at night. Up to 50% of people with DPN may be asymptomatic; some of these may present with a painless foot ulcer.[11]

Diagnosis
DPN can be diagnosed only after a complete clinical examination of the limbs, including sensory and motor nerve testing. Other causes of peripheral neuropathy (such as vitamin B12 deficiency, hypothyroidism, uremia and chronic inflammatory demyelinating polyneuropathy) should be excluded before making a diagnosis of DPN.

Management
Includes:

- Foot care and education - all patients with DPN are at increased risk of foot ulceration.
- Stable and optimal blood glucose control – observational studies suggest that neuropathic symptoms improve with less fluctuation in blood glucose levels.[11]
- Pharmacologic therapy for neuropathic pain – A number of medications have proved in randomized trials to be useful in the treatment of painful diabetic neuropathy. These medications include: Tricyclic antidepressants (amitriptyline, nortriptyline, imipramine); Anticonvulsants (gabapentin, pregablin, sodium valproate, lamotrigine); SSRI antidepressants; Opioids (oxycodone, morphine). All these drugs have side effects that may limit their therapeutic usefulness. Generally, it is advisable to start with a low dose and gradually titrate the dose to symptom relief in order to lessen the severity of side effects. Combinations of some drugs may be used in cases of severe neuropathic pain.[12]
- Non-pharmacologic therapies – for patients with severe neuropathic pain, multidisciplinary interventions (such as podiatric, physical, behavioral and psychosocial therapies) may assist with long-term management.

2. Peripheral Arterial Disease (PAD) in Diabetes

Etiology

Diabetes mellitus is asssociated with proatherogenic changes due to increases in vascular inflammation, derangements in the cellular components of the blood vessels (vascular endothelial cells and vascular smooth muscle cells), and alterations in platelet function and hemostatic factors. These vascular abnormalities lead to the formation of atherosclerotic plaques, resulting in narrowing or occlusion of large and small arteries. Poor glycemic control, smoking, hypertension and hyperlipidemia are associated with more accelerated atherosclerosis. In people with diabetes, PAD tends to involve the blood vessels below the knee, resulting in poor oxygen delivery to the tissues of the foot (ischemia). This will contribute to skin ulceration, poor wound healing and development of gangrene.

Damage to the sympathetic nerves that control the blood flow to the foot is termed autonomic neuropathy. Autonomic neuropathy results in high intraluminal flow rates, a tendency to vasodilation and resultant arteriovenous shunting.[13] Arteriovenous shunt formation in the lower limb of diabetics is associated with reduced nutritive skin blood flow[14] and with inflammatory changes in the skin.

Diabetes and smoking are the strongest risk factors for PAD. Other factors are hypertension, hyperlipidemia and advanced age.

Diagnosis

a) Clinical Evaluation

History - depending on disease severity, individuals with PAD present with a spectrum of symptoms ranging from no pain, intermittent claudication (leg muscle pain or fatigue on walking), rest pain in the leg or foot, to nonhealing foot ulcers and gangrene.

Physical examination – decreased or absent arterial pulses in the distal leg and foot, and signs of chronic vascular insufficiency (cool, dry skin; absence of hair growth; dystrophic nails; dependent rubor; pallor on elevation of the foot).

b) Diagnostic Testing

"Noninvasive" arterial studies are performed to evaluate perfusion of the lower limbs:

- Ankle-Brachial Index (ABI) – is a reproducible and reasonably accurate noninvasive measurement for the detection of PAD and disease severity. It is the ratio of the systolic blood pressure in the ankles (dorsalis pedis and posterior tibial arteries) and the systolic blood pressure in the arms (brachial artery). The measurements are taken with a blood pressure cuff and a hand-held Doppler. ABI is considered normal if it is in the range of 0.91 – 1.30.
A lower blood pressure in the ankle, resulting in an ABI of <0.9 is indicative of PAD. Severe arterial obstruction usually has an ABI <0.4.

However, the ABI is less reliable in confirming the diagnosis of PAD in some individuals with diabetes and in the elderly, who tend to have calcified, poorly

compressible blood vessels, resulting in ABI values being inaccurate and often elevated at >1.30.[15]

- Toe blood pressure – systolic blood pressure in the toes may be a more accurate measure of the severity of PAD in individuals with calcified arteries in the lower leg, because vessel calcification does not extend to the digital arteries. There is growing evidence that toe blood pressures may have a role in predicting foot ulceration risk and predicting successful wound healing.[15] Toe blood pressure >40mmHg is favorable.

In an individual with confirmed PAD, further tests to assess the location and severity of arterial occlusion may be performed. These involve vascular laboratory measurements and angiography. In Saskatchewan, referral to a Vascular Surgeon is required for these tests; angiography is performed only when revascularization procedures are being considered.

Management of PAD

The presence of PAD in a person with diabetes indicates high risk for other cardiovascular disease (CVD), including coronary artery disease and stroke. Therefore, medical mangement of PAD includes all the measures routinely recommended for CVD risk reduction, as follows: smoking cessation; optimal glycemic control; treatment of hypertension; use of an anti-platelet agent (e.g. Aspirin); use of lipid-lowering drugs (e.g. Statins); exercise. Smoking cessation and a supervised exercise (walking) program are the two most important interventions in the treatment of symptomatic PAD. Treatment with lipid-lowering drugs has been shown to reduce the severity of symptoms of intermittent claudication.[15, 16]

All individuals with diabetes and PAD should receive regular preventive foot care to minimize the risk of developing foot ulceration and amputation.

Individuals with severe PAD or symptoms suggestive of critical limb ischemia (rest pain in leg or foot, progressive or non-healing ulceration, or gangrene) require referral to a Vascular Surgeon. The urgency of this referral depends on the individual's presenting clinical symptoms, medical history and comorbidities.

3. Diabetes Related Dermatology

With diabetes comes the increased occurrence of skin changes and pathology. Autonomic neuropathy can effect innervation of the sweat glands, leading to dry skin. This condition may seem minor, but, in conjunction with the triad of diabetic peripheral arterial disease, neuropathy and injury, this may lead to skin ulceration and can be limb threatening. The health care practitioner should be aware that presentations such as small skin cracks, thick nails and callus formation can be precursors to diabetic foot wounds. Such conditions need to be monitored and treated by the appropriate practitioner to prevent them from progressing to ulceration. Self-treatment of these skin conditions by the individual with diabetes is a common cause of new diabetic foot ulcers.

Management
Early detection and treatment, along with patient education on self-management is the key to prevent progression of minor dermatologic pathology to ulceration. Self-management of hyperkeratosis and anhydrosis would involve regular use of pumice stone or foot file (non sharp instruments) and skin emollients or lotions.

Podiatric or medical management would involve precise scalpel debridement of hyperkeratoses, including reduction of callus and enucleation of helomata. Methods to reduce pressure on these sites can be devised (e.g. accommodative footwear, deflective padding, insoles, and/or orthoses). There may also be a need for specialty hypertrophic nail debridement. Conservative or surgical removal of involuted or ingrowing toenail edges may also be required.

4. Deformities in the Diabetic Foot

Etiology
Distal muscle atrophy is commonly associated with loss of motor nerve function. The outcome of weakening intrinsic foot muscles is overall muscle imbalance, which produces changes in foot structure and gait.[17] The resulting deformity and limited range of motion contribute to increased mechanical stress (compression and shear forces) on corresponding areas of the foot.

Diagnosis
Toe deformities can be easily recognized by the professional. A flexible deformity that involves extension contracture at the metatarsophalangeal joint with flexion contracture at the proximal interphalangeal joint is commonly referred to as a "claw toe". While a fixed deformity that involves extension contracture of the metatarsophalangeal joint and flexion contracture of the interphalangeal joint is commonly referred to as a "hammer toe."[17] Claw and hammer toes can be a sign of distal muscle atrophy and neuropathy. Claw toes and hammer toes increase pressure on the metatarsal heads, dorsal interphalangeal joints and apices of the toes. Increased ground reaction forces may lead to callus formation and ulceration at the metatarsal heads and digital apices. Hallux rigidus (complete loss of dorsiflexion at the first metatarsophalangeal joint), or hallux limitus (partial loss of dorsiflexion at the first metatarsophalangeal joint) also predisposes to ulceration, since the toe-off phase of gait requires 45 degrees of metatarsophalangeal joint dorsiflexion.[17] Limitation in dorsiflexion of the hallux can lead to increased ground reaction forces at the joint with callus formation and increased risk of ulceration. It is important to note that any pedal deformity has the potential to increase local tissue pressures and can be the underlying cause of tissue breakdown. Bunions (hallux abducto valgus deformities) for example, place the medial aspect of the first metatarsophalangeal joint at risk. This is due to an increased forefoot width, which causes excessive pressure within the toebox of standard fitting shoes.[17] The identification and management of such deformities is critical in the prevention of ulceration.

Management
Treatments for such deformities involve conservative offloading with padding, the use of custom orthoses and specialty shoes. More aggressive management would involve orthopedic surgery, which should comprise of joint fixation, arthroplasty or digital amputation. The goal of any treatment plan is to reduce the mechanical stress at the problematic area, thus reducing risk of skin ulceration.

5. Charcot Foot (Neuropathic Osteoarthropathy, Diabetic Neuroarthropathy)

Definition
Charcot Foot is a progressive condition characterized by joint dislocation, pathological fractures and severe destruction of pedal architecture. This may result in debilitating deformity or amputation. The condition is associated with severe peripheral neuropathy and the most common etiology is diabetes mellitus. Eichenholz's classification divides osteopathy into developmental, coalescent and reconstructive stages.

Etiology
The etiology of Charcot foot most likely is a combination of both the neuro-vascular and neuro-traumatic theories. It is generally accepted that trauma superimposed on a severely neuropathic extremity can precipitate the development of an acute Charcot foot. With the development of autonomic neuropathy, there is an increased blood flow to the foot, resulting in osteopenia and a relative weakness of the bone. The presence of sensory neuropathy renders the patient unaware of the precipitating trauma and often profound bone destruction that occurs during ambulation. A vicious cycle ensues whereby the patient continues to walk on the injured foot, thereby allowing further bone and joint damage to occur.[18]

Did You Know?
In a person with diabetes, a warm swollen red foot, without a portal of entry for skin infection should be considered an Acute Charcot Arthropathy until investigations have proven otherwise.

Diagnosis of Acute Charcot Arthropathy

a) Clinical Examination
The following characteristics, in the presence of intact skin, are often diagnostic of acute Charcot arthropathy:

- Profound unilateral swelling
- Increased skin temperature
- Erythema
- Joint effusion
- Bone resorption (seen on x-ray) in an insensate foot

In more than 75% of cases, the patient will present with some degree of pain in an otherwise insensate foot. In more than 75% of cases, the diagnosis is complicated by the fact that patients first present with concomitant ulceration, which raises the possibility of cellulitis and osteomyelitis.

b) Investigation

- X-Rays - plain radiographs are invaluable in ascertaining the presence of osteoarthropathy. In most cases, no further imaging studies will be required to make a correct diagnosis. However, with a concomitant wound, it may be difficult to differentiate between acute Charcot arthropathy and osteomyelitis based solely on plain radiographs.

- Laboratory and other imaging studies may be required including: white blood cell count (WBC); erythrocyte sedimentation rate (ESR); a bone biopsy; nuclear medicine scans; magnetic resonance imaging (MRI).

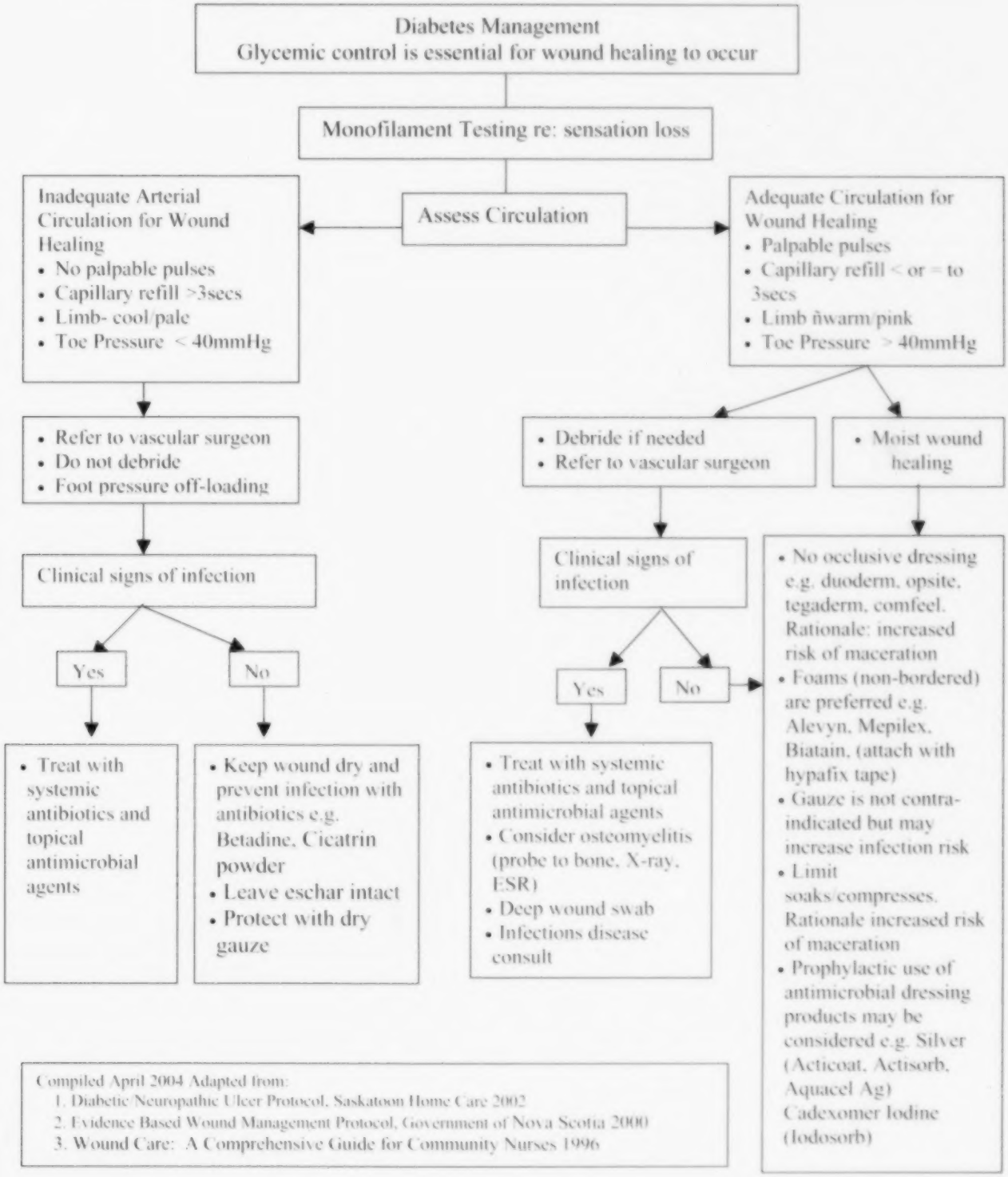
Did You Know?
The key to preventing further deformity, while waiting for further investigations and specialist referral, is non-weight bearing of the affected limb. Ideally an urgent referral should be made to a podiatrist or orthopedic surgeon.

c) Management of Acute Charcot Arthropathy

- Immobilization and reduction of stress are the mainstays of treatment for acute Charcot arthropathy. Use offloading modalities, such as wheelchair, crutches, walker, casts, braces/splints, surgical shoe with insert.
- Following a period of offloading, a reduction in skin temperature and edema indicates the stage of quiescence, at which point, the patient progresses into the post-acute phase of treatment.
- Progression to protected weight bearing is permitted, usually with the aid of some type of assisting device.
- Through the use of appropriately applied total contact casts or other offloading modalities, most patients may safely ambulate while bony consolidation of fractures progresses.
- The mean time of rest and immobilization (casting followed by removable cast walker) prior to return to permanent footwear is approximately 4-6 months.

Reconstructive surgery may be considered if a deformity or instability exists that cannot effectively be controlled or accommodated by prescription footwear or bracing. If the arthropathy is identified in its early stages and non-weight-bearing is instituted, surgery is usually unnecessary.[18]

MANAGEMENT OF FOOT ULCER ALGORITHM


Diabetes Management
Glycemic control is essential for wound healing to occur
Monofilament Testing re: sensation loss
Assess Circulation
Inadequate Arterial Circulation for Wound Healing
• No palpable pulses
• Capillary refill >3secs
• Limb- cool/pale
• Toe Pressure < 40mmHg
Adequate Circulation for Wound Healing
• Palpable pulses
• Capillary refill < or = to 3secs
• Limb ñwarm/pink
• Toe Pressure > 40mmHg
• Refer to vascular surgeon
• Do not debride
• Foot pressure off-loading
• Debride if needed
• Refer to vascular surgeon
• Moist wound healing
Clinical signs of infection
Yes
No
Clinical signs of infection
Yes
No
• Treat with systemic antibiotics and topical antimicrobial agents
• Keep wound dry and prevent infection with antibiotics e.g. Betadine, Cicatrin powder
• Leave eschar intact
• Protect with dry gauze
• Treat with systemic antibiotics and topical antimicrobial agents
• Consider osteomyelitis (probe to bone, X-ray, ESR)
• Deep wound swab
• Infections disease consult
• No occlusive dressing e.g. duoderm, opsite, tegaderm, comfeel. Rationale: increased risk of maceration
• Foams (non-bordered) are preferred e.g. Alevyn, Mepilex, Biatain, (attach with hypafix tape)
• Gauze is not contra-indicated but may increase infection risk
• Limit soaks/compresses. Rationale increased risk of maceration
• Prophylactic use of antimicrobial dressing products may be considered e.g. Silver (Acticoat, Actisorb, Aquacel Ag) Cadexomer Iodine (Iodosorb)

Compiled April 2004 Adapted from:
1. Diabetic/Neuropathic Ulcer Protocol, Saskatoon Home Care 2002
2. Evidence Based Wound Management Protocol, Government of Nova Scotia 2000
3. Wound Care: A Comprehensive Guide for Community Nurses 1996

MANAGEMENT OF DIABETIC FOOT COMPLICATIONS WITH ULCERATION

Establishing an interdisciplinary approach is an optimal way to improve clinical outcomes of prophylaxis and treatment of all types of problem wounds.[19] The complex and multifaceted nature of wounds in an individual with diabetes requires a coordinated interdisciplinary approach. [20] The wound treatment team may include some or any of the following disciplines: family physicians, diabetologists, nurses, dietitians, vascular surgeons, podiatrists, wound resource nurse, diabetes educators, and orthotists. (See Appendix 1 for list of professionals).

Additional information pertaining to wound healing and factors that affect healing and the prevention and control of infections is provided in Appendices 6 and 7 respectively.

The following guidelines may be utilized to provide an optimum wound environment for healing:

1. **Wound Cleansing**
    - Do not use skin cleansers or antiseptic agents (e.g. povidone iodine, iodophor, sodium hypochlorite solution (Dakin's), hydrogen peroxide, acetic acid) to clean wounds with healthy, granulating tissue.
    - Use normal saline, sterile water or non-cytotoxic wound cleansers to clean wounds.
    - Fluid used for cleansing should be warmed to at least room temperature.
    - Cleanse wounds initially and at each dressing change.
    - To reduce surface bacteria and tissue trauma, the wound should be gently irrigated with 100 to 150 mls. of solution.
    - Use enough irrigation pressure to enhance wound cleansing without causing trauma to the wound bed. Safe and effective ulcer irrigation pressures range from 4 to 15 p.s.i. Pressure of 4 to 15 p.s.i. is achieved by using the following held 4-6 inches from the wound:
        - 35 ml syringe with a 19 gauge angiocath or blunt needle, or
        - Single-use, 100 ml. saline squeeze bottle

2. **Wound Dressings**

Consider what you are replacing when you think about selecting a dressing. The skin's functions are: maintenance of body temperature, protection and immunity, sensory perception, absorption, synthesis of Vitamin D, excretion of waste products, maintenance of body pH and provision of a waterproof layer. [21] The dressing replaces the skin for the time the wound is in situ and so must attempt to manage many of these functions. Additional information is provided in Appendix 8.

There are four guidelines for selecting a wound dressing:

- Function (learn about dressings by function)
- Consider safety, effectiveness, user-friendliness and cost effectiveness
- Change dressings based on an assessment of the patient, the wound and the dressing, not on standardized routines
- Adapt the wound treatment to optimize healing throughout the phases of the healing[22]

Moisture retentive dressings optimize the wound environment and promote healing[10], provided there is sufficient arterial blood flow to support healing.

Dry dressings are indicated for individuals with insufficient blood flow for wound healing when there is a stable dry eschar in situ or dry gangrene of the toe. In these individuals wounds need to be kept dry, using betadine or Cicatrin powder and gauze dressing.

Did You Know?
Interactive dressings are only recommended when the expected outcome of treatment is healing based on the assessment that there is adequate blood supply to the area.

Consider the following criteria for selecting an **interactive dressing:**[23]

- Maintains a moist environment
- Controls wound exudate, keeping the wound bed moist and the surrounding intact skin dry
- Provides thermal insulation
- Protects from contamination of outside micro-organisms
- Maintains its integrity and does not leave fibers or foreign substances within the wound
- Does not cause trauma to the wound bed on removal
- Is simple to handle, and is economical of costs and time

Use clinical judgment to select the type of moist wound dressing suitable for the ulcer, considering: [23]

- Etiology of the wound,
- Individual's general health status, goals of care, and individual choice;
- Individual's living environment;
- Location of the wound;
- Size of the wound, including depth and undermining;
- Pain;
- A packing that will loosely fill the wound cavity;
- Exudate: type and amount;
- Risk of infection;
- Type of tissue involved;
- Phase of the wound healing process;

- Frequency of the dressing change;
- Comfort and cosmetic appearance;
- Where and by whom the dressing will be changed; and
- Dressing availability, cost and cost effectiveness

Dressing treatments should be done for a few dressing changes before changing products in order to evaluate optimal outcomes. Use clinical judgment to decide when a dressing is not effective for the wound and seek further assistance. [23]

Did You Know?
Literature reflects that the benchmark for healing is week 4. If a wound is not healing by week 4, it will not be healed by week 12.

3. Management of Wound Infection

Diabetic foot infections should be described in terms of severity of infection (local and systemic signs) and wound location and appearance. This will assist in classifying diabetic foot infections into two categories:

- Mild to moderate or non-limb threatening infections; and,
- Severe or limb threatening infections

The above classification will generally facilitate management.

a) Mild to moderate or non-limb threatening infections

These infections are characterized by:

- No evidence of systemic toxicity/infection;
- Superficial ulceration, skin fissure or puncture wound;
- Less than 2 cm of surrounding skin cellulitis;
- No significant vascular disease or ischemia;
- No bone or joint involvement

Most non-limb threatening infections are caused by gram-positive bacteria, but anaerobic bacteria should be considered if there is a foul smell or necrotic tissue. These infections can usually be managed in the outpatient setting, with close medical follow-up.

Management includes:

- Optimal diabetic therapy;
- Rest and elevation of the affected limb;
- Appropriate wound care (debridement if indicated) and dressings;
- Empiric oral antibiotic therapy as per Canadian guidelines, taking into account recent use of any antibiotics by the individual and local antimicrobial resistance patterns.[24, 25] Topical antimicrobials in isolation are not recommended in the treatment of diabetic foot infection;

- Follow-up by the physician and wound care nurse within 48 to 72 hours is required. Most of these infections will respond to appropriate antibiotic therapy within 3 days;
- If the cellulitis is slow to respond, worsens, or recurs while on antibiotic therapy the wound should be cultured (deep wound culture from base of ulcer/wound), and admission to hospital for intravenous antibiotic therapy and other investigations should be considered. [18]

Did You Know?
Two centimeters of erythema around a diabetic lower limb wound may be indicative of limb-threatening infection.

b) Severe or limb-threatening infections
These infections are characterized by:

- Evidence of systemic toxicity (fever, tachycardia, hyperglycemia, leukocytosis);
- Cellulitis extending >2cm beyond the ulcer or skin lesion; edema or deep tissue involvement such as abscess formation;
- Foul odor; lymphangitis;
- Severe vascular disease and ischemia;
- Bone or joint involvement; gangrene;
- Increasing pain (may indicate osteomyelitis). Palpation of bone by probing diabetic pedal ulcers is strongly correlated (90% positive predictive value) with the presence of underlying osteomyelitis [26]

Most limb threatening infections are polymicrobial, involving gram-positive and gram-negative bacteria and anaerobes. If the foot wound is chronic and if the individual has been on antibiotics recently, resistant bacteria and Pseudomonas must be considered. [18]

Management:
Management of severe diabetic foot infections requires emergent hospital admission. A complete evaluation of the patient is required, as there are usually other complications of diabetes such as renal disease, hypertension, peripheral arterial disease and neuropathy which will influence overall management. Initial investigations of the foot infection involves:

- A deep wound culture to assess bacterial etiology and antibiotic sensitivities;
- Blood culture; CBC; ESR;
- X-rays to assess for soft tissue gas and osteomyelitis

Initial management of the wound infection should include appropriate wound care and debridement, and empiric use of broad-spectrum IV antibiotics. Antimicrobial therapy will be influenced by the patient's prior antibiotic use, the nature of the wound and the patient's kidney function, and will be modified according to wound

culture results and initial response to treatment.[24,25] If the patient does not respond dramatically to initial therapy within 48 hours, consultations to Infectious Diseases and Vascular Surgery may be required.

4. **Ulcer Management: Debridement**

Vascular assessment is recommended for ulcers in lower extremities prior to debridement to rule out vascular compromise.[23]

Foot ulcers with dry eschar need not be debrided if they are stable/unchanging. Monitor these wounds routinely for evidence of complications that would require debridement.[23]

Provide local wound care considering debridement, infection control and a moist wound environment.

Select the method of debridement most appropriate to:

- Patient's condition and goals of treatment
- Type, quantity and location of necrotic tissue; and
- Depth and amount of fluid

Sharp debridement should be used if there is an urgent need for debridement, as with advancing cellulitis or sepsis.[23]

Surgical debridement for diabetic foot ulcers should include resection of bone and joint resection when these structures are involved. This procedure must be followed by culture-directed antibiotic therapy. Surgical debridement is considered the cornerstone of management of diabetic foot ulcers. Necrotic tissue removed on a regular basis can expedite the rate at which a wound heals and has been shown to increase the probability of attaining full secondary closure.[18] Joint resection or partial amputation of the foot is necessary if osteomyelitis, joint infection, or gangrene is present.[18]

Enzymatic debridement involves the topical application of commercially prepared enzymes to necrotic tissue to break it down.[23]

Autolytic debridement involves using dressings that maintain moisture within the wound bed supporting the body's own ability to cleanse itself. The action of enzymes present in wound fluids will break down necrotic tissue.[27]

Mechanical debridement involves the use of force to remove nonviable tissue or debris. Common methods are:

- Forceful wound irrigation;
- Wet-to-dry dressings changes that remove debris adhered to the dressing; and,
- Whirlpool treatment.[23]

5. Pain Management

Assess all patients for pain related to the wound or its treatment. Consider analgesics prior to dressing changes and/or wound debridement. Refer to the client's physician for management as indicated.

Did You Know?
The presence of pain in a previously insensate foot can be one of the first and most important indicators of infection.

6. Prevention of Wound Trauma

Pressure offloading is essential for wound healing to occur, especially if there is loss of protective sensation in the foot..

The following options may be considered and provided by a podiatrist or orthopedic specialist:[18]

- Accommodative dressings - felt, foam, deflective padding
- Total contact orthoses - custom walking braces
- Shoe cut-outs
- Healing sandal/surgical shoe with molded insole
- Half shoes or wedge shoes
- Removable walking braces with rocker bottom soles
- Foot casts or boots
- Total contact casting
- Patellar tendon bearing braces
- Assistive devices - crutches, walker, cane, etc.
- Total non-weightbearing - crutches, bed, wheelchair

Did You Know?
Scar tissue is at increased risk of re-ulceration because it will not achieve greater than 80% of the pre-injury tensile strength and has reduced vascularity. Close monitoring and prevention measures will help protect these at risk areas.

7. Diabetes Management

All patients with diabetic foot ulcers and their caregivers should have an understanding of their condition and the resources available to optimize their general health, diabetes management and ulcer care. [28]

Diabetes education is essential as an empowerment strategy for diabetes self-management and prevention or reduction of complications such as foot ulcers. [28]

Components that should be included in the Diabetes Education Programs are:

- Why People with Diabetes Need to Take Care of Their Feet (Brochure produced by Saskatchewan Health)
- How to achieve the recommended glycemic targets through regular exercise, healthy eating and lifestyle and medical management of diabetes with medications and/or insulin. Additional information from the CDA is provided in Appendix 9 "Staying Healthy with Diabetes".

Recommended targets for glycemic control as per the 2003 Clinical Practice Guidelines	A1C %	FPG/preprandial PG (mmol/l)	2-hr postprandial PG (mmol/l)
Target for most patients	≤ 7.0	4.0-7.0	5.0-10.0
Normal range (consider for patients in whom it can be achieved safely)	≤6.0	4.0-6.0	5.0-8.0

Did You Know?
Poor glycemic control is a factor contributing to poor healing outcomes.

8. Nutrition Management

Prevent clinical nutrient deficiencies by ensuring that the patient is provided with optimal nutrition. Nutritional management includes adequate protein, energy and micronutrient intake to support healing while still optimizing blood glucose, blood lipid and blood pressure management. Some individuals may benefit from the use of special nutritional products and supplements. A referral to a registered dietitian for assessment is recommended.

9. Adjunctive Therapies

These therapies may not be readily available in all regions of the province. Recalcitrant diabetic foot ulcers may be treated by alternative therapies when they have proved unresponsive to optimal conventional treatment. Some of these options are:

- Electrical stimulation
- Hyperbaric oxygen
- Negative pressure wound therapy[28]

If healing is delayed despite best practice and the above adjunctive therapies are unavailable, biological agents may be a consideration. A wound care specialist should be contacted.

10. Traditional Therapies

Practitioners need to be aware of, and respectful of traditional therapies used by various cultures in our province.

The Regina Qu'Appelle Health Region's (RQHR) Diabetes Foot Care Working Group has developed some additional materials regarding the unique needs of First Nations and Métis people and the numerous barriers to prevention and care. The materials reflect a holistic approach and contain recommendations from community members and care providers. Contact the RQHR Regional Diabetes Initiative (306-766-4774) for additional information.

CONTINUITY OF CARE

Individuals with diabetes moving between care settings should have the following information related to their care transmitted to all care providers:

- Need for on-going nutritional support
- On-going diabetes education and care
- On-going medical management
- Risk factors identified
- Need for pressure reducing footwear/equipment or ambulation restrictions
- Details of healed ulcers
- Site and size of existing ulcers
- Type of dressing currently used and frequency of change
- Follow up care requirements i.e. podiatry
- Any allergies or reactions to wound care products

Did You Know?
Communication among health care providers is key to successful diabetes management.

RECOMMENDATIONS FOR HEALTH CARE ORGANIZATIONS

Educational Recommendations

- Design, develop and implement educational programs that reflect a continuum of care. The program should include a structured, comprehensive and organized approach to prevention of diabetic foot complications, and effective treatment protocols that promote healing as well as prevent recurrence.

- Educational programs should target appropriate health care providers, individuals with diabetes, family members and caregivers. Present information at an appropriate level for the target audience in order to maximize retention and facilitate a carry over into practice.

- Involve and collaborate with the individual with diabetes, and caregiver, whenever possible, in diabetic foot treatment and prevention strategies. Other areas of education may include information regarding appropriate footwear, and where to access this, and the roles of the various health professionals.

APPENDIX 1: INTERDISCIPLINARY APPROACH TO PREVENTION AND MANAGEMENT OF DIABETIC FOOT COMPLICATIONS

Template: Regional Diabetes Foot Programs should develop a list of available health professionals in the following care provider management categories within their region, and any referral contacts external to the region.

Diabetes Management Health Care Providers	Services Provided
Family Physician	- Ongoing care; referral to specialists, wound care nurses, diabetes education, podiatry - Regular diabetes medical review and management - Regular screening for neuropathy and vascular disease - Management of wounds and liaison with wound care nurses
Diabetologist/ Endocrinologist	- Management of diabetes - Preventative management of foot complications
Diabetes Nurse Educators (may work independently or be part of a Diabetes Education program)	- Diabetes education, including lipids and blood pressure management for people with diabetes and their families. Done through individual and group sessions. Includes education re meal planning, blood sugar monitoring, activity, medications, foot care, complication screening etc. - Support the initiation of insulin therapy; perform foot exams/monofilament testing and blood pressure monitoring. - Provide advice and consultative services to health care professionals, including health care students, to provide education and information about best practices in supporting people to self-manage their diabetes and prevent the complications. - Limited work on initiatives to support healthy eating and physical activity and lifestyles to prevent type 2 diabetes in the community
Dietitian (may work independently or be part of a Diabetes Education program)	- Provide education for people with diabetes and their families regarding diabetes self-management including general nutrition, appropriate meal planning for optimal blood glucose, blood lipid, blood pressure and weight management. Done through individual and group sessions. - May address other areas of diabetes education (i.e. blood glucose monitoring, foot screens/monofilament testing) - Screen for nutritional adequacy as it relates to wound prevention and healing - Provide appropriate nutrient recommendations, practical interventions and education to individuals and caregivers
Wound Care Specialist/Resource Nurse	- An RN with specialty training in wound management - Consultation with other disciplines - Patient and staff educational role

Diabetes Management Health Care Providers	Services Provided
	- Participate in research and clinical trials for wound management - Participate in the development and implementation of clinical care guidelines
Acute Care Nurse	- Wound Care - Coordination of the other disciplines involvement in patient care needs - Assess foot risk - Basic diabetes education - Teach insulin/medication administration - Basic foot care education
Home Care Nurse	- Assess foot risk - Basic diabetes education - Basic foot care education - Provide all levels of support to diabetes persons with diabetes - Teach diabetes management - Provide referrals for nutritional counseling to the Dietitian - Teach medication/insulin administration - Referrals to appropriate health care professional for high risk foot care - Wound care - Consultation with other disciplines and client care coordinator/assessor
Nurse Practitioner in Primary Care	- Assess foot risk - Basic diabetes education - Basic foot care education - Provide all levels of support to persons with diabetes - Teach diabetes management - Provide referrals for nutritional counseling to the Dietitian - Teach medication/insulin administration - Wound care - Consultation with other disciplines and client care coordinator/assessor - Referrals to appropriate health care professional for high risk foot care
LTC Nurse	- Assess foot risk - Basic diabetes education - Basic foot care education - Provide all levels of support to persons with diabetes - Make arrangements for routine foot care - Wound care

Diabetes Management Health Care Providers	Services Provided
Interostomal Therapy RN	- Consultation, direct patient care, education, research and administration - Consult on wound referrals received from other health professionals - Direct individualized care including assessment of diabetic foot risk, assessment of wounds and recommendations for treatment - Refer to other appropriate agencies - Education of health professionals in the care of the diabetic foot - Family centered foot care education with emphasis on prevention - Participate in research and clinical trials for wound management - Participate in the development and implementation of clinical care guidelines
Advanced Foot Care Nurse	- Basic and advanced foot care/treatment - Foot assessments (basic & advanced) - Education of health professionals in the assessment and care of the at risk foot - Basic foot education to the public - Family/patient centered foot health and foot care education with emphasis on prevention of foot conditions - Wound care
Podiatrist	- Diabetic foot care/footwear education - Prevention of diabetic foot ulceration through routine management of pathological skin (i.e., hyperkeratoses) and pathological nails (i.e., hypertrophy, ingrowth) - Management of underlying biomechanical conditions leading to increased or abnormal pressures - Management of diabetic foot ulceration including routine debridement, dressing, and pressure offloading with deflective padding and/or custom prescribed orthotic inserts
Occupational Therapist	- Education (e.g., care of skin/foot during ADL's, properly fitting shoes, pressure management/relief, energy conservation, relaxation techniques) - General mobility and transfer assessments and intervention - Equipment prescription (e.g., mobility aides, wheelchair and seating, bathroom equipment, total lift, pressure relief surfaces) - Positioning - Splinting/orthotics - Sensation testing (e.g., light touch, proprioception, pressure, thermal, monofilament) - Cognitive/perceptual assessment (e.g., ability to manage meds, foot care instructions) - Home modification recommendations

Diabetes Management Health Care Providers	Services Provided
Physical Therapist	- Prescription of exercise to optimize blood glucose control and minimize complications secondary to diabetes - Facilitate offloading techniques and progress weight-bearing and range of motion as tolerated - Oversee use of adjunctive therapies as appropriate to facilitate wound healing - Prevent development of muscle wasting and contractures, while maintaining functional abilities - Evaluate ankle brachial indices using Doppler ultrasound to measure arterial sufficiency - Provide education as necessary
Orthotist	- Design, fabricate and fit an orthotic device that will reduce or stop damaging forces to the foot or its joints through the use of various types of orthotic appliances. Examples of orthotics that might be used in these situations are a PTB (patellar tendon bearing) orthosis, total contact walking boot, or an AFO (ankle/foot orthosis).
Pedorthist	- Pedorthics (Orthopaedic Footwear) - Shoe modifications to manufactured footwear - Custom made orthopedic footwear - Various types of custom made foot orthotics (arch supports) - Therapeutic footwear for individuals who have swollen or sensitive feet and those who require protection against friction and pressure - Extra depth and extra width shoes (to accommodate inserts, etc.)
Orthopedic/Foot and Ankle Surgeon	- Achilles tendon lengthening procedure for offloading - Reconstructive surgery of the foot and ankle

Vascular Surgeon	– Assess the degree of macrovascular and microvascular disease in the individual with diabetes – Assess the viability of the limb, presence of gangrene, neuropathy or infection - using a complete history and physical examination - non-invasive vascular lab/ankle brachial index, toe pressure, wave plethysmography, oxygen saturation - Angiography – Classification of diabetes foot ulcers using well documented classification systems (neuropathic, ischemic, combined) – Revascularization of the ischemic limb-non-invasive (angioplasty) invasive (bypass surgery) – Perform amputations for diabetes foot complications
Cast Technician	– Application and removal of total contact casts for pressure offloading of Charcot foot (only done with specialized training)
Infectious Diseases Specialist	– Advise on optimal antibiotic therapy for foot infections, particularly in the septic patient, for osteomyelitis or gangrene, or when antibiotic resistance, toxicity or allergies are factors
Plastic Surgeon	– Provide a variety of surgical options including skin grafts, local flaps or transfer of distant tissue with free flap construction

APPENDIX 2: DIABETES FOOT SCREEN

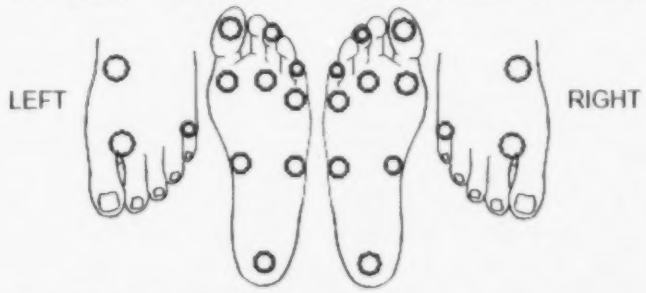
Diabetes Foot Screen

Name (Last, First, MI) _____ Date: _____/_____/_____

Fill in the following blanks with a "Y" or "N" to indicate findings in the right or left foot.

	R	L
Is there a history of a foot ulcer?	_____	_____
Is there a foot ulcer now?	_____	_____
Is there a claw toe deformity?	_____	_____
Is there an abnormal foot shape?	_____	_____
Are the toenails, thick or ingrown?	_____	_____
Is there heavy callus build-up?	_____	_____
Is there swelling?	_____	_____
Is there elevated skin temperature?	_____	_____
Is there limited ankle dorsiflexion?	_____	_____
Is there foot or ankle muscle weakness?	_____	_____
Can the patient see the bottom of their feet?	_____	_____
Are the shoes appropriate in style and fit?	_____	_____
Is there an absent pedal pulse?*	_____	_____

Note the level of sensation in the circles:
+ = Can feel the 5.07 filament - = Can't feel the 5.07 filament



Skin Conditions on the Foot or Between the Toes:

Draw in: Callus ▤, Pre-ulcer ▦, Ulcer ■ (note length and width in cm)
Label with: **R** - redness, **M** - maceration, **D** - dryness, **W*** - warm **T**-Tinea, **Dis*** - discoloration

RISK CATEGORY:
____ 0 No loss of protective sensation
____ 1 Loss of protective sensation
____ 2 Loss of protective sensation with either high pressure (callus/deformity), or poor circulation
____ 3 History of plantar ulceration, neuropathic fracture (Charcot foot) or amputation

Rev. 03/22/02 LSUHSC Diabetes Foot Program Performed by: _____

* Revised by the Saskatchewan working group for the Clinical Practice Guidelines for Prevention and Management of Diabetes Foot Complications

Diabetic Foot Screen Instructions

Section 1:

The twelve questions can be answered in the 'R' (right foot) or 'L' (left foot) blank with a 'Y' or 'N' to indicate a positive or negative finding. Fill in all blanks.

Question 1: Is there a history of foot ulcer?
Question 2: Is there a foot ulcer now?
The purpose of these questions is to determine if the patient currently has or has ever had an ulcer on the foot. History of a foot ulcer places the patient at an increased risk of developing another foot ulcer and increases the potential of future amputation. The patient with a past or present foot ulcer is considered permanently in Risk Category 3.

Question 3: Is there toe deformity?
Question 4: Is there an abnormal shape of the foot? This is determined by inspecting the general shape of the patient's foot. Conditions to consider include: prominent bony areas, partial or complete amputations of the foot or toes, clawed toes, bunions, or "Charcot Foot".

A Charcot Foot is a neuropathic foot may present with swelling, increased temperature, and little or no pain. Advanced cases show progressive signs of deformity into what is referred to as a "rocker bottom" or "boat shaped" foot. A patient with a Charcot Foot is permanently in Risk Category 3.

Question 5: Are the toenails thick or ingrown?
Identify Mycotic, significantly hypertrophic or ingrown nails.

Question 6: Is there callus buildup?
Identify focal and/or heavy callus.

Question 7: Is there swelling?
Swelling may stem from a variety of causes such as a Charcot fracture, infection, or "venous stasis".

Question 8: Is there elevated skin temperature?
Elevated, localized skin temperature can indicate excessive mechanical stress, bone fracture, or an infection and requires further evaluation. Skin temperature can be measured by a commercially available thermometer or by touch. A temperature elevation of greater than 2 degrees Celsius on the thermometer, or a noticeable difference by touch when compared with the contralateral foot, is considered clinically significant.

Question 9: Is there muscle weakness?
A manual muscle test of the feet and great toe dorsi and plantar flexion.

Question 10: Can the patient see the bottom of his/her feet?
Obesity and/or lack of flexibility can prevent a patient from seeing his/her feet. Self-inspection and foot care is difficult with these limitations often requiring family or outside assistance

Question 11: Is the patient wearing improperly fitted shoes?
An improperly fitted shoe may create foot pressures that lead to further complications. Patients with sensory loss often wear shoes that are too short and/or narrow resulting in ischemic ulcers on the medial or lateral metatarsal heads or the toes of a foot with claw toe deformity. Properly sized added depth shoes with soft custom molded insoles are usually indicated for patients with loss of sensation and deformity to prevent ulceration.

Question 12: Does the patient use footwear appropriate for his/her category?
See risk and management categories.

Section 2:

Examine the foot and record problems identified on the Foot Screen form. Draw calluses, pre-ulcerative lesions (a closed lesion i.e. blister or hematoma) or open ulcers as accurately as possible, using the appropriate "pattern" to indicate what type of condition is present. Label areas that are red "R", warm "W" (warmer than the other parts of the foot or the opposite foot), dry "D" or macerated "M" (friable, moist, soft tissue) on the corresponding location of the foot drawing provided on the screen form.

A sensory exam using the 10-gram monofilament is performed at the indicated on the foot drawing. Responses are recorded in the appropriate circles. A positive response is recorded in the corresponding circle with a "+" if the patient is able to feel the filament, and a negative response is recorded with a "-" if the patient cannot feel the filament.

Section 3:

The accurate placement of patients into their respective Risk Category is a key element in the Foot Screen. The higher the Risk Category, the higher the risk a patient has of recurrent foot ulceration, progressive deformity, and ultimately, amputation of the foot. All patients, regardless of category, should be re-screened annually and should be given basic patient education.

A detailed description of the Risk Category is available in the document "Risk and Management Categories for the Foot."

Comprehensive Diabetes Lower Extremity Amputation Prevention (LEAP) Program

Filament Application Instructions

Note: The sensory testing device used with the LSU Medical Center Diabetic Foot Screen is a nylon filament mounted on a holder that has been standardized to deliver a (5.07) 10-gram force when properly applied. Research has shown that a patient who can feel the (5.07) 10-gram filament in the selected sites has "protective sensation" and has a reduced risk of developing plantar ulcers. Additional information about the LEAP Program and disposable test kits is available is available at: http://www.hrsa.gov/leap

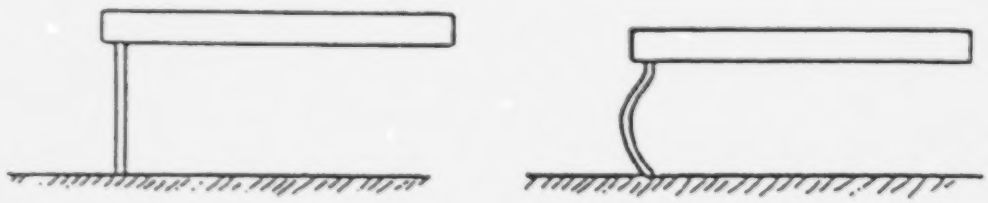
1. Use the (5.07) 10-gram filament to test for "protective sensation".

2. Test the sites indicated on the Diabetic Foot Screen.

3. Apply the filament perpendicular to the skin's surface (see diagram A).

4. The approach, skin contact and departure of the filament should be 1 1/2 seconds.

5. Apply sufficient force to cause the filament to bend (see diagram B).



A B

6. Do not allow the filament to slide across the skin or make repetitive contact at the test site.

7. Randomize the selection of test sites and time between successive tests to reduce patient guessing.

8. Ask the patient to respond "Yes" when the filament is felt and record the response on the Diabetic Foot Screen Form.

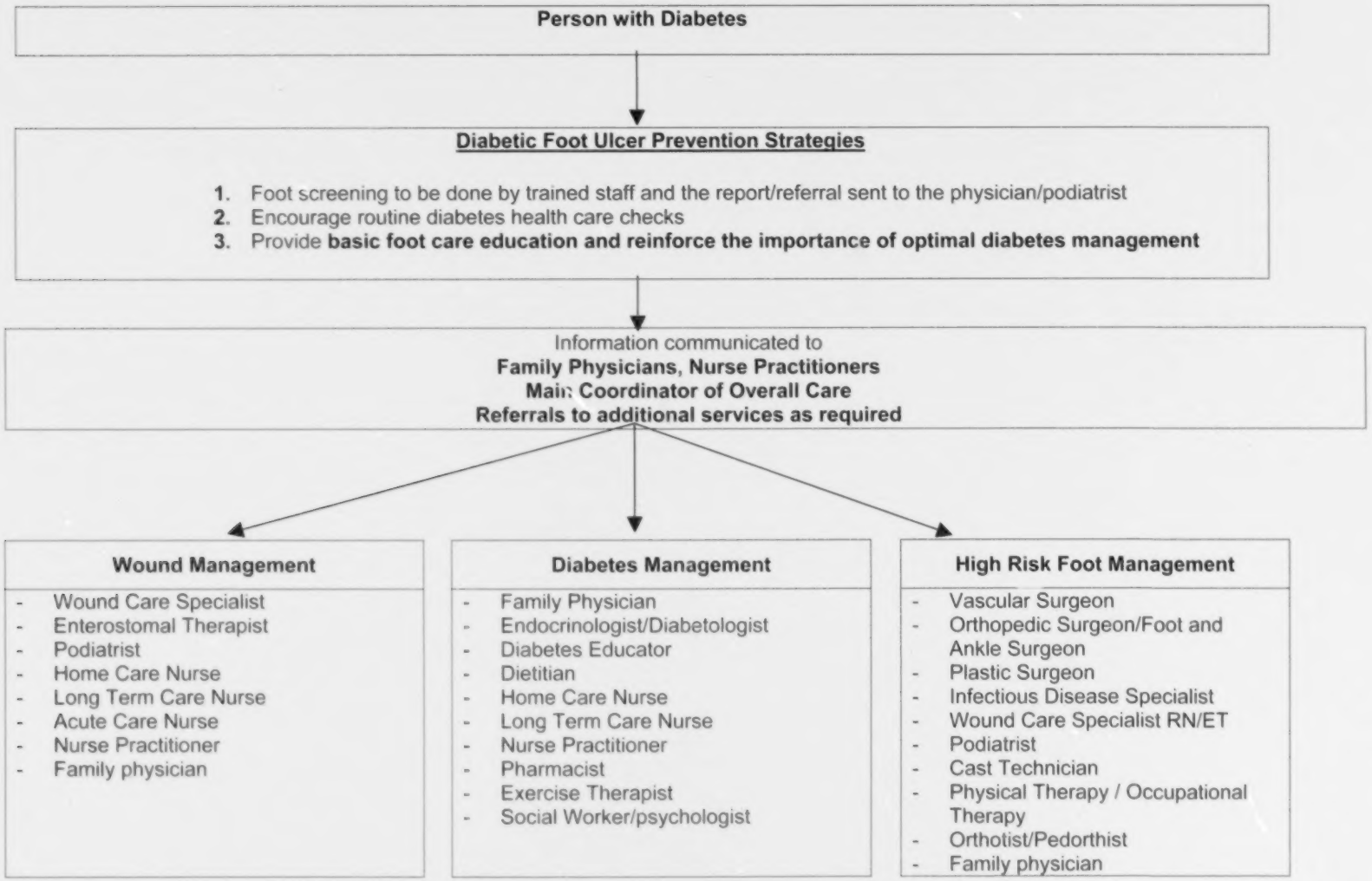
9. Apply the filament along the margin of and NOT on an ulcer, callus, scar or necrotic tissue.

10. Have the patient close his/her eyes while the filament test is being performed.

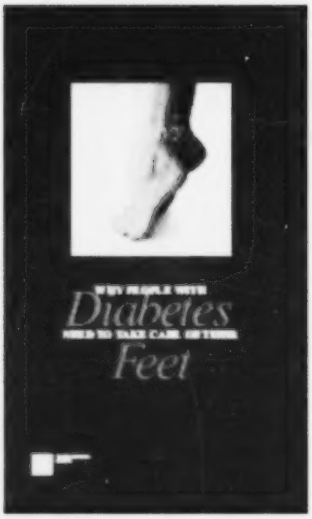
REV 9/99

APPENDIX 3: REFERRAL TEMPLATE

Referral Template for Prevention and Management of Diabetic Foot Complications


Person with Diabetes
Diabetic Foot Ulcer Prevention Strategies
1. Foot screening to be done by trained staff and the report/referral sent to the physician/podiatrist
2. Encourage routine diabetes health care checks
3. Provide basic foot care education and reinforce the importance of optimal diabetes management
Information communicated to
Family Physicians, Nurse Practitioners
Main Coordinator of Overall Care
Referrals to additional services as required
Wound Management
- Wound Care Specialist
- Enterostomal Therapist
- Podiatrist
- Home Care Nurse
- Long Term Care Nurse
- Acute Care Nurse
- Nurse Practitioner
- Family physician
Diabetes Management
- Family Physician
- Endocrinologist/Diabetologist
- Diabetes Educator
- Dietitian
- Home Care Nurse
- Long Term Care Nurse
- Nurse Practitioner
- Pharmacist
- Exercise Therapist
- Social Worker/psychologist
High Risk Foot Management
- Vascular Surgeon
- Orthopedic Surgeon/Foot and Ankle Surgeon
- Plastic Surgeon
- Infectious Disease Specialist
- Wound Care Specialist RN/ET
- Podiatrist
- Cast Technician
- Physical Therapy / Occupational Therapy
- Orthotist/Pedorthist
- Family physician

APPENDIX 4: SASKATCHEWAN HEALTH DIABETES FOOT BROCHURE INFORMATION



Why People with Diabetes Need to Take Care of Their Feet
This brochure is available by contacting the Provincial Diabetes Coordinator at 306-787-3025.

An important part of managing your diabetes is **Taking Care of Your Feet**

People who have diabetes are more likely to have problems with poor blood flow (circulation) or loss of feeling (sensation) in their feet. Loss of sensation and poor circulation to the foot may lead to sores that are slow to heal.

Loss of feeling or sensation is caused by damage to the nerves in the lower legs and feet. This nerve damage occurs as a result of blood sugar levels that have been high over a long period of time. As a result of loss of feeling or sensation, the person with diabetes may not be aware of temperature, pressure or pain.

For example...

If your feet get too hot, such as with the use of a hot water bottle or stepping into hot water, your feet can suffer a burn and **you will not feel it.**

You may not feel injuries, such as blisters developing, if your shoes are too tight.

You may not feel anything when you step on a sharp object. You can damage your feet and not even know it.

Foot damage can lead to serious lifelong problems. That is why you need to take care of our feet!

DO'S For Taking Care of Your Feet

DO *wash your feet daily with warm water and mild soap.*

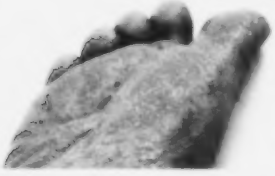
DO *dry your feet well, especially between the toes.*

DO *use lotion to keep skin soft, but not between the toes.*

DO *change your socks every day. Wear socks that are in good condition and that do not have tight elastic at the band*

DO *wear shoes and socks all the time. Make sure nothing is inside your shoes when you put them on.*

DO *wear shoes that fit well with good support and have lots of room for the toes. When buying new shoes be fitted for them late in the day to allow for foot swelling.*



DO *check your feet daily for sores, cracks, nail problems, infections or color changes. Use a mirror to see the bottom of your feet. If you find any problems, get help from your health care provider right away.*

DO *cut toenails straight across.*

DO *be active every day. Exercise helps the blood flow to the feet.*

DO *have your feet checked on a regular basis by your doctor, nurse or a foot doctor (podiatrist/chiropodist).*
Remove your shoes and socks to remind them to check your feet.

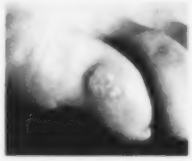
Don'ts For Taking Care of Your Feet

Don't *smoke. Smoking causes less blood flow to your legs and feet.*

Don't *walk barefoot indoors or outdoors.*

Don't *use chemicals such as alcohol, peroxide or iodine on your feet unless directed by a health care professional.*

Don't *cut corns or calluses with sharp objects, such as a razor blade or use corn or wart removal products.*



Don't *bathe in water that is too hot. Check the temperature of the water with your elbows or arm before getting in to the bathtub or shower.*

Don't *go out in cold weather without wearing socks and shoes or boots.*

Don't *use a heating pad, hot water bottle or heated bag on your feet.*

Don't *get sunburned. Cover your feet to protect them from the sun.*

Don't *wear tight-fitting shoes; wrinkled or tight socks/stockings; tight sandals, straps or garters.*

Don't *cross your legs at the ankles or knees for long periods of time, as this decreases blood flow to your feet.*

Don't *let the skin on your feet get dry and cracked. Use lotion to keep the skin soft, but not between your toes.*

Don't *leave any sores, scrapes or skin cracks on your feet or legs unattended. Watch the area closely for signs of infection (redness, swelling, drainage, warm to touch, foul odor). If the area does not heal or does not improve in 48 hours you should seek medical help.*

Remember when visiting your health care provider; always remove your shoes and socks to remind them to check your feet!

APPENDIX 5: SAMPLE WOUND CLASSIFICATION TOOLS

University of Texas Foot Wound Classification System

Grade/depth: "How deep is the wound?"					
Stage/ Comorbidities: "Is the wound infected, ischemic, or both?"	Depth	Grade			
		0	I	II	III
	A	Pre- or post-ulcerative lesion completely epithelialized	Superficial wound not involving tendon, capsule or bone	Wound penetrating to tendon or capsule	Wound penetrating to bone or joint
	B	Pre- or post-ulcerative lesion completely epithelialized with infection	Superficial wound not involving tendon, capsule or bone with infection	Wound penetrating to tendon or capsule with infection	Wound penetrating to bone or joint with infection
	C	Pre- or post-ulcerative lesion completely epithelialized with ischemia	Superficial wound not involving tendon, capsule or bone with ischemia	Wound penetrating to tendon or capsule with ischemia	Wound penetrating to bone or joint with ischemia
	D	Pre- or post-ulcerative lesion completely epithelialized with infection and ischemia	Superficial wound not involving tendon, capsule or bone with infection and ischemia	Wound penetrating to tendon or capsule with infection and ischemia	Wound penetrating to bone or joint with infection and ischemia

From: Armstrong, DG, Lavery, LA, Harkless, LB. Diabetes Care 1998; 21: 855-859
Lavery, LA, Armstrong, DG, Harkless, LB. J Foot Ankle Surg. 1996; 35:528-531

WAGNER ULCER CLASSIFICATION TOOL

In the Wagner Classification System, foot lesions are divided into six grades based on depth of the wound and extendt of tissue necrosis.

- **Grade 0** — Pre-ulcer. No open lesions, skin intact, may have deformities, erythematous areas of pressure or hyperkeratoses.
- **Grade 1** — Superficial ulcer. Disruption of skin without penetration of the subcutaneous fat layer. Superficial infection with or without cellulitis may be present.
- **Grade 2** — Full-thickness ulcer. Penetrates through fat to tendon, or joint capsule without deep abscess or osteomyelitis.
- **Grade 3** — Deep ulcer which may or may not probe to bone, with abscess, osteomyelitis, or joint sepsis. Includes deep plantar space infections or abscesses, necrotizing fasciitis and tendon sheath infections.
- **Grade 4** — Denotes gangrene of a geographical portion of the foot, such as toes, forefoot or heel. The remainder of the foot is salvageable, though it may be infected.
- **Grade 5** — Gangrene or necrosis, to the extent that the foot is beyond salvage and will require a major limb- or life-sparing amputation.

Failure of the Wagner classification to specifically address infection and ischemia within each grade has been recognized and hybrid schemes have been developed to account for these important attributes of foot ulcers. A simplified system which only attaches modifiers for ischemia (A) and infection (B) to the well-known Wagner system is presented in the table below, recognizing that grades 3 through 5 usually have some degree of infection inherent within these lesions.

Grade	Lesion
0	**No open lesions: may have deformity or cellulitis**
A	Ischemic
B	Infected
1	**Superficial Ulcer**
A	Ischemic
B	Infected
2	**Deep ulcer to tendon, or joint capsule**
A	Ischemic
B	Infected
3	**Deep Ulcer with abscess, osteomyelitis**
A	Ischemic
B	Infected
4	**Localized gangrene- forefoot or heel**
A	Ischemic
B	Infected
5	**Gangrene of entire foot**
A	Ischemic
B	Infected

APPENDIX 6: GENERAL WOUND HEALING INFORMATION

WOUND HEALING

The wound healing process is defined by the Wound Healing Society (WHS) as "a complex and dynamic process that results in restoration of anatomic continuity and function".

Wound healing, though often taken for granted, is a very dynamic and delicate process. The wound healing process is a cascade of events beginning with injury to tissue. Appropriate wound management is dependent on an understanding of the normal repair process, the factors affecting this process and the interventions that can impact either positively or negatively on the outcome. Healing progresses in a series of overlapping phases.

The following are the phases of wound healing[23]:

Hemostasis
Hemostasis is characterized by clot formation resulting in cessation of bleeding. This process is enhanced by a 5-10 minute phase of vasoconstriction. The ultimate effect of coagulation is the conversion of fibrinogen to fibrin stabilizing the initial clot. Clot formation facilitates the migration of cells and begins the process of fibroblast proliferation into the wounded area.

Platelet activity, integral to the establishment of a hemostatic plug, is mediated by the release of platelet-derived growth factor, platelet factor 4, transforming growth factor α and transforming growth factor β. These substances stimulate the synthesis of extracellular matrix and initiate tissue repair.

Medical conditions or medications that alter the body's ability to clot will slow down the initiation of healing.

Inflammation
This is the body's defense mechanism against bacterial invasion.

Neutrophils and monocytes are attracted at the same time to the wound site. The neutrophils are the most abundant cells present in this phase of healing. Neutrophils migrate through the blood vessels to accumulate in the periphery of the wounded tissue. The main function of these cells is to phagocytose local bacteria and debris. The inflammatory environment stimulates the release of toxic reactive oxygen intermediates that destroy the contaminating bacteria.

The later phases of inflammation are characterized by conversion of monocytes to macrophages. Wound macrophages continue the process of phagocytosis. They generate chemotactic factors and these factors attract additional inflammatory cells. Macrophages are also thought to release growth factors critical to the coordination of granulation tissue formation.

Any medical conditions (autoimmune diseases) or anti-inflammatory medications will alter this phase and delay healing.

Proliferation

The phase of proliferation overlaps inflammation. The key cells of this phase of healing are the fibroblasts and myofibroblasts. Fibroblasts secrete a loose extracellular matrix that is rich in collagen. Collagen synthesis peaks 5-7 days post injury. Once this extracellular matrix is deposited. the fibroblasts cease collagen production.

Myofibroblasts have been implicated in a process of wound healing called wound contraction. Wound contraction is the reduction of a tissue defect by the centripedal movement of the surrounding skin. This process of contraction will peak at approximately two weeks after the injury and varies in its ability to reduce wound size by the depth of the wound and the tension of the surrounding tissue.

Angiogenesis or the formation of new blood cells occurs simultaneously with the above two cellular processes. This is the process where capillaries bud from pre-existing small vessels found in close proximity to the wound to form granulation tissue. Granulation tissue is very metabolically active and requires a rich blood supply. If there is insufficient arterial inflow to support the formation of this tissue, fibroblasts and macrophages will stop proliferating and healing will be altered.

Re-epithelialization occurs as keratinocytes migrate across the wound defect. This process is aided by moisture at tissue level. This epithelial tissue is very fragile and is unattached to the wound surface until complete coverage has occurred.

Maturation

Remodeling of the immature tissue matrix occurs at the same time as granulation tissue formation. The very vascular granulation tissue is gradually replaced and remodeled forming scar tissue. The composition of the extracellular matrix is in a state of constant change from the time it is first deposited. Tensile strength of the scar tissue is created by collagen deposition and also realignment and remodeling of the tissue. This process occurs for a period of months or years after initial wound closure. The functional strength of scar tissue can only regain up to 70-80% of its pre-injury strength and so is less resistant to tissue breakdown than it was previous to the injury.

Factors Affecting Wound Healing

Metabolic Disorders	• Systemic diseases, like hepatic, renal, cardiac or lymphedema can lead to increased wound edema and subsequent increased risk of infection and a reduction in epithelialization. • Individuals with diabetes have an altered immune response. • Optimal wound healing is achieved by a holistic approach including blood sugar and blood pressure management.
Nutrition	• Nutritional deficiencies are associated with a prolonged inflammatory response and delayed wound healing. Lack of key vitamins and minerals can be a significant deterrent to healing.
Medications	• The most frequently encountered medications that are detrimental to wound healing are: systemic steroids, alcohol, NSAIDS and antineoplastics.
Ischemia	• Wound hypoxia is harmful to all wound healing. Adequate evaluation of the individual's circulatory status is essential.
Infection	• All chronic wounds harbor bacteria, but as long as there are no overt clinical signs and symptoms of infection, treatment is not indicated. • The presence of foreign fibres (gauze) or necrotic debris in a wound may predispose it to infection. • Topical antibiotics should not be chosen at random and should be used for a maximum of 14 days.
Treatment Regimes	• Wound cleansing should be performed using normal saline or sterile water at a pressure per square inch (psi) of 4-15. This can be achieved through the use of a 35 ml syringe and 19 gauge angiocath or 100 ml single use saline squeeze bottle. • Wipe down the wound edges only. Gauze wiped across newly epithelializing tissue can remove all new cell growth. • Consider non-adherent dressings to reduce the risk of tissue trauma in minimally exudating wounds. Maintain a moist, not wet, wound environment.
Aging	• Aging reduces the rate of healing and alters all phases of healing. Elderly individuals typically have increased skin fragility and special care must be taken to reduce tissue damage with dressing changes.
Smoking	• Nicotine is a vasoconstrictive drug and will limit oxygen supply to tissues and reduce the potential for healing. Smoking has been shown to cause an increase in scar formation and an increased risk of infection.
Malignancy	• Wounds are at risk for malignancy. If healing does not occur, a biopsy should be obtained.
Psychological Well-being	• Stress and insomnia may impact upon wound healing.

APPENDIX 7: GENERAL INFECTION PREVENTION AND CONTROL INFORMATION

Infection Prevention and Control [23]

The following infection prevention and control procedures should be implemented when carrying out wound care.

Handwashing	• All personnel must wash hands with soap and water, for 10 seconds, or as an alternative, an antiseptic, waterless hand rub product, prior to and after any contact with the patient, and after the removal of gloves.
Clean Technique	• Clean technique involves strategies used in patient care to reduce the risk of transmission of microorganisms from one person to another or from one place to another. • Clean technique means no touch dressing technique, clean supplies and sterile normal saline or recommended wound cleanser. Whether an individual is allowed to shower or bathe depends on the clinical situation and the decision must be approved by the attending physician. • No touch dressing technique is a method of changing surface dressings without directly touching the wound or any surface that might come in contact with the wound. • The accepted practice in continuing care centres and the community is clean technique.
Aseptic Technique	• Aseptic technique is the purposeful prevention of the transfer of germs from one person to another by keeping the microbial count to an irreducible minimum, and includes the application of principles for assuring that cross-contamination does not occur. • Aseptic technique must be used during dressing changes, wound irrigation and debridement procedures to avoid introduction of microorganisms into the wound. • Sterile gloves must be worn when hands touch the wound.
Wound Cleansing Agents	• Before any wound cleansing agent is used, it should be inspected for any evidence of damage to the bottle, leaking, foreign material, mold or fungus. • The wound cleansing agent should be handled in a manner to avoid contamination of the fluid itself, the inside of the neck of the bottle and the inside of the top of the cap. • Containers of sterile normal saline, if not contaminated, may be resealed and labeled with a 24-hour expiration time. • Solutions used for wound cleansing should never be "topped up" from bulk containers into small ones. • Unused contents of single use non-resealable containers of normal saline should be discarded following use. • Wound cleansing agents dispensed from a spray applicator (e.g. Sea-Clens) must be used according to the manufacturer's directions and be dedicated to single patient use. When cleansing a wound with a spray applicator product, the container must be held 15 20 centimetres from the wound bed to prevent contamination of the bottle and its contents.
Dressings, Pastes, Gels	• Opened dressings, pastes or gels should be labeled, dedicated to single patient use and stored in a clean area between use. • Outer packaging and containers of pastes and gels must be handled with clean hands. Care must be taken not to contaminate the contents of the packages or containers. • Manufacturer's written recommendations for shelf life and storage conditions should be followed.

Waste Disposal	• All used dressings and disposable supplies should be contained in plastic bags and placed in the general waste. • Irrigation solution and wound drainage may be disposed of by carefully pouring (to prevent splashing) into the hopper or toilet. • Silver nitrate solution should be disposed of in a sealed container. • All used disposable sharp instruments (e.g. needles, lancets, scalpel blades, broken or easily broken glass items) should be placed at the point of use, in a puncture-resistant, leak-proof, impervious container for disposal.
Personal Protective Equipment	• Gloves should be worn for contact with the wound or wound drainage. • Cover gowns or aprons, masks and eye protection should be worn by caregivers when splash or spray from wound drainage is anticipated. • These measures will assist in prevention of transmission of infection to the caregivers and to other patients/residents.
Antibiotic Resistant Organisms	• If the individual is known to be colonized or infected with a significant antibiotic-resistant organism (e.g. methicillin-resistant Staphylococcus aureus (MRSA) or vancomycin-resistant Enterococcus (VRE), this should be communicated to personnel responsible for Infection Prevention and Control in the health care facility or home care program. • When the patient is transferred between facilities, Infection Prevention and Control personnel in the receiving health care facility or home care program must be notified in advance of the time of transfer.

APPENDIX 8: GENERAL INFORMATION FOR DIABETIC FOOT ULCER DRESSING CHOICES

Wound Type	Description	Character	Bacterial Profile	Blood Supply	Dressing Choices
Post-Surgical	Approximated	Moist	Sterile	Adequate	Gauze, foam, hydrofiber (depends on amount of exudate)
Dry stable eschar or toe gangrene	Necrotic	Dry/ black or grey	Colonized Infected	Inadequate	Dry out the wound. Betadine, cicatrin, gauze
Necrotic tissue in situ	Necrotic Sloughy	Dry/black or grey Moist/ yellow or gray Malodorous	Colonized Infected	Adequate	Debriding products Cadexomer iodine depending on moisture level. If largely exudating, hydofiber and/or foams may be used to control drainage.
Clean Wound	Granulating	Granulating (red base) Moist May bleed easily	Contaminated or colonized	Adequate	Heavily exudating - hydrofibres or alginates combined with foams, combination products. Moderately exudating - foams ± hydrofiber (depends on length of wear time) Lightly exudating - thin foams Wounds with depth fill with ribbon gauze, hydrofibre or alginate.

MANAGEMENT

CANADIAN DIABETES ASSOCIATION | ASSOCIATION CANADIENNE DU DIABÈTE

Staying healthy with diabetes

Both type 1 and type 2 diabetes are serious conditions, and can lead to the same complications. But you can do many things to stay well. Talk to your doctor about all of the following points. They are important for basic diabetes care. Your doctor and your healthcare team will work with you to ensure you get the best care.

The important first steps are:

- Eat according to a healthy meal plan.
- Increase your physical activity.
- Learn as much as possible about diabetes.

Blood glucose

You and your healthcare team should set goals for your blood glucose levels. It is important to recognize that you may need to add pills and/or insulin to your lifestyle changes (meal planning and increased activity), to achieve your blood glucose targets. Ask about a blood glucose meter to help track your blood glucose levels.

Blood pressure

High blood pressure can lead to eye disease, heart disease, stroke and kidney disease. You may need to change your eating and exercise habits and/or take pills to keep your blood pressure at or below 130/80 mm Hg.

Healthy eating

Ask your doctor to refer you to a registered dietitian to learn about healthy eating. You should follow Canada's Guidelines for Healthy Eating, which includes limiting the amount of fat you eat.

Physical activity

If you have type 2 diabetes, you should do at least 150 minutes of aerobic exercise per week. You may need to start with as little as 5 to 10 minutes per day of brisk walking. If you are just starting to be active, check with your doctor first.

Do you know your targets for good blood glucose and blood pressure control? Remember, lowering your blood glucose and blood pressure (even a little) will help you become healthier and stay that way.

Refer to the back page of this brochure to find your recommended target range and check regularly with your doctor or healthcare team to meet your goals.

Cholesterol

High cholesterol and other fats in the blood can lead to heart disease and stroke. You may need to change your eating and exercise habits and/or take pills to keep your blood fats at healthy levels.

Weight

Reaching and maintaining a healthy weight will help you control your blood glucose, blood pressure and blood fat levels.

Eye disease

You need to be seen by an eye specialist who will dilate your pupils and check for signs of eye disease. Your regular doctor cannot do this special test in his or her office. Ask for a referral to an eye specialist.

Foot care

Take off your shoes and socks at every visit (even if your doctor or healthcare team forget to ask you). Ingrown toenails, cuts and sores on the feet can lead to serious infections. Learn about proper foot care.

Depression and anxiety

These are common feelings in people with diabetes and can negatively affect your diabetes control. Speak to your doctor or healthcare team if you feel you might have depression or anxiety

Smoking

Smoking and diabetes are a dangerous mix. If you are serious about quitting, your doctor or healthcare team can help. Keep trying; your health is worth it.

Kidney disease

The earlier you catch signs of kidney disease the better. You must have your urine tested regularly for early signs of kidney disease. Your doctor may prescribe pills to delay more damage to your kidneys.

Nerve damage

Tell your doctor or healthcare team if your hands or feet ever feel numb or have "pins and needles."

Problems with erection

Trouble getting and maintaining an erection is a very common problem in men with diabetes. Do not be shy about talking to your doctor or healthcare team about it. They may be able to suggest ways to solve the problem.

Stay healthy by asking the right questions.

Be an informed patient. Know what tests you need to check for the complications of diabetes. Talk to your doctor about these tests.

MONITORING YOUR BLOOD GLUCOSE

Monitoring your blood glucose is important. Review your home glucose monitoring record with your doctor regularly. And make sure that your meter is providing accurate results by checking against the results of a blood test at the lab once a year.

TESTS FOR DIABETES CARE

The following are important tests for basic diabetes care. You may need some tests more often than indicated.

Target blood glucose and blood pressure levels may differ, depending on your health.

WHEN	WHAT TEST?
At diagnosis	• Kidney test (type 2): urine test performed at the lab • Eye examination (type 2): through dilated pupils by an eye care specialist • Nerve damage test (type 2): using a 10-g monofilament • Test for erection problems (type 2): questions about your ability to get and maintain an erection • Cholesterol and other blood fat tests (type 2): a blood test
Approximately every 3 months	• A1C blood test (goal: less than 7.0%, less than 6.0% if possible) • Blood pressure (goal: at or below 130/80 mm Hg) • Review of home blood glucose monitoring record
Every 6 to 12 months	• Kidney check • Foot exam at every visit (at least once a year) and right away for an ingrown toenail or any cut or sore that doesn't heal • Meter check against the results of a blood test at the lab at least once a year
Every 1 to 2 years	• Eye examination by an eye specialist - Type 2: every 1–2 years* - Type 1: once a year† if you are over age 15 and have had diabetes for at least 5 years
Every 1 to 3 years	• Cholesterol and other blood fats tests
Regularly/ Periodically	• Questions about erection problems • Questions about depression and/or anxiety

*For young children and pregnant women, the timing and type of test may be different.

†More often if eye disease is present.

AIC (measure of blood glucose levels over time)

Blood pressure

Cholesterol

DO YOU KNOW YOUR ABCs?

If you have diabetes, you are at increased risk for heart disease and stroke, and other complications such as eye and kidney disease, nerve damage and foot problems. Keeping your blood glucose, blood pressure and cholesterol in a healthy range can reduce your risk of complications.

Learn your diabetes ABCs. Talk to your doctor about the Canadian Diabetes Association's recommendations for diabetes management, what targets are healthy for you, and how to achieve and maintain them over time.

ABC	RECOMMENDED TARGETS	MY GOALS
AIC	7.0% or below	
Blood pressure	130/80 mm Hg	
Cholesterol	LDL: 2.0 mmol/L or lower Total cholesterol to HDL ratio: below 4	

Take your diabetes knowledge to the next level. Subscribe to* Diabetes Dialogue *magazine by visiting www.diabetesdialogue.ca or by calling 1-800-BANTING (226-8464).

1-800-BANTING (226-8464)
www.diabetes.ca info@diabetes.ca

CANADIAN DIABETES ASSOCIATION | ASSOCIATION CANADIENNE DU DIABÈTE

316327 06-299 09-06 0-1500

Appendix 10: Glossary

Atherosclerotic	A thickening, hardening, and loss of elasticity of the blood vessel (artery walls) due to deposits of cholesterol plaques
Arteriovenous shunting	The passage of blood directly from arteries to veins without going through the capillary network
Callus	A thickened area of the skin due to increased keratin production caused by chronic direct pressure or continuous shearing stress, the result of a foot deformity or poorly-fitting shoes. A callus may form a central core or plug of tissue where pressure is greatest
Capillary refill	The rate at which blood refills empty capillaries. It can be measured by pressing a fingernail until it turns white, and taking note of the time needed for color to return once the nail is released. The capillary refill time (CRT) is a common measure of peripheral perfusion
Cellulitis	Pressence of swelling, redness and heat. Indicating an inflammatory reaction in the skin
Collagen	An insoluble fibrous protein of vertebrates that is the chief constituent of the fibrils of connective tissue (as in skin and tendons)
Debridement	Removal of dead tissue and foreign matter from a wound
Dorsiflexion	Turning upward of the foot or toes or of the hand or fingers
Edema	Excess fluid in the skin and subcuateous tissues causing swelling sufficiently pronounced to leave a clear imprint of the pressure by a finger
Electrical stimulation	The use of an electrical current to transfer energy to a wound
Eschar	Thick, hard, black, leathery, necrotic, devitalized tissue
Enzymatic debridement tissues	The use of selective enzymatic ointments to remove necrotic
Erythema	Abnormal redness of the skin caused by capillary congestion. It is one of the cardinal signs of inflammation
Exudate	Fluid, cells or other substances that have slowly leaked from other cells and blood vessels through small breaks in the cell membranes
Glycemic control	The management of blood glucose in persons with diabetes to achieve recommended blood glucose targets

Glycosolation	The linkage of glucose molecules to proteins, causing a change in the protein structure
Gram-negative	A type of bacteria identified by characteristic Gram staining properties
Gram-positive	A type of bacteria identified by characteristic Gram staining properties
Hyperbaric oxygen	Oxygen at greater than atmospheric pressure that can be applied either to the whole client inside a pressurized chamber or to a localized area (such as an arm or leg) inside a smaller chamber
Hammer toe	A deformity of the toe in which the toe is bent upward like a claw. Most commonly seen in the second toe, the condition may be congenital or acquired
Hallux valgus	Angulation of the great toe away from the midline of the body or towards the other toes of the foot
Hyperlipidemia	The presence of excess fat or lipids in the blood
Hypertension	Persistently high blood pressure
Interdisciplinary team	A pool of two or more disciplines working together
Induration	Increased hardness/firmness of the tissue
Ischemic	A deficient supply of blood to a body part usually due to obstruction of the inflow of arterial blood (by the narrowing of arteries by spasm or obstruction)
Mechanical debridement	Removal of foreign material and devitalized or contaminated tissue from a wound by physical forces, rather than by chemical (enzymatic) or natural (autolytic) forces
Monofilament 5.07 (Semmes-Weinstein)	A device calibrated to apply 10 grams of force when pressed against the skin. Used to identify patients with decreased sensation of the skin
Necrosis/necrotic tissue involved	Devitalized tissue, either wet or dry, irrespective of tissue
Neuropathy	Any and all disease or malfunction of the nerves

Orthoses/orthotics	Shoe inserts designed to support, align, or improve the function of the foot. They are also often commonly referred to as 'orthotics'
Off-loading	The reduction of pressure or taking the load off of a specific area to promote healing
Osteomyelitis	Infection of the bone, with involvement of the bone marrow
Patellar tendon bearing braces	Used to transfer weight-bearing forces from the orhtosis thru the patellar tendon to reduce weight bearing through foot and ankle
Positioning	Moving the client or body part to provide comfort and to reduce the risk of skin breakdown, promote skin integrity, and/or healing
Recalcitrant wound	A chronic wound which has failed to respond to optimal standard wound care
Renal disease	Kidney disease
Retinopathy	Disease of the retina, the light-sensitive membrane at the back of the eye
Sepsis	The presence of bacteria or other toxins in the blood or other tissues
Undermining/tracking	A closed passageway under the surface of the skin that is open only at the skin surface. Generally it appears as an area of skin ulcertation at the margins of the ulcer with skin overlaying the area. Undermining often develops from shearing forces
Venous stasis	Inadequate flow of blood in the veins from the skin to the heart

APPENDIX 11: REFERENCES

[1] Health Council of Canada: ì Why Health Care Renewal Mattersî March 2007

[2] International Working Group on the Diabetic Foot: International Consensus on the Diabetic Foot and Practical Guidelines on the Management and the Prevention of the Diabetic Foot 2003

[3] Saskatchewan Health: Risk Identification of the Foot in Diabetes (2003)

[4] Boulton AJM, Kirsner RS, Vileikyte L (2004) Neuropathic Diabetic Foot Ulcers, The New England Journal of Medicine 351:48-55

[5] Steeper R (2005) A Critical Review of the Etiology of Diabetic Neuropathic Ulcers, Journal of Wound Care 14;3, 101-103

[6] Laing P (1998) The Development and Complications of Diabetic Foot Ulcers, The American Journal of Surgery 176 (Suppl 2A): 11S-19S

[7] Keyser JE (1992) Foot Wounds in Diabetic Patients Post Graduate Medicine 91:4:98-105

[8] Mayfield, J.A. Sugarman JR (2000) The Use of the Semmes ñWeinstein Monofilament and Other Threshold Tests For Preventing Foot Ulceration and ì Amputation in Persons With Diabetesî . The Journal of Family Practice 49:11:S17-S29

[9] Canadian Diabetes Association 2003 Clinical Practice Guidelines For the Prevention and Management of Diabetes in Canada www.diabetes.ca

[10] RNAO Nursing Best practice Guideline Assessment and Management of Stage 1-4 Pressure Ulcers , August 2002

[11] Boulton A.J., Vinik AI, Arezzo J.C. et al, Diabetic Neuropathies: a statement by the American Diabetes Association, Diabetes Care, 2005 Apr; 28: 956-62

[12] Reiger L., Jensen B.: The Rx Files ì Chronic Non-Malignant Painî newsletter, Sept 2005, www.RxFiles.ca

[13] McMillan DE (2001) Hemorheology: Principles and Concepts. In: Bowker J.H., Pfeifer M.A. (eds) Levin and OíNealís The Diabetic Foot (6th edn.) St. Louis MI: Mosby Inc.

[14] Hamdy O., Abuelenin K., Veves A., (2001) Microcirculation of the Diabetic Foot In: Johnstone MT, Veves A (eds) Diabetes and Cardiovascular Disease Totowa NJ: Humana Press

[15] American Diabetes Association: Peripheral Arterial Disease in People with Diabetes (Consensus Statement), Clinical Diabetes 22: 181-189, 2004

[16] Mohler, E.R., Hiatt W.R., Creager M.A.; Cholesterol Reduction with Atorvastatin Improves Walking Distances in Patients with peripheral arterial disease, Circulation 108; 1481-1486; 2003

[17] Mellissa F. Green, Zarrintaj Alibadi, Bryan T. Green, Department of Internal Medicine and Comprehensive Diabetic Foot Clinic, University of South Alabama, Mobile; South Med J 95 (1): 95-101, 2002 *Diabetic Foot: Evaluation and Management*

[18] Fryberg RG, Zgonis T, Armstrong DG et al. Diabetic Foot Disorders: A Clinical Practice Guideline (2006 revision). The Journal of Ankle and Foot Surgery 2006; 45; (supplement 5); S28-S36.

[19] Gottrup F., Holstein P., Jorgensen B., Lohmann M., Karlsmar T.: (2001) A New Concept of a Multidisciplinary Wound Healing Centre and A National Expert Function of Wound Health. Archives of Surgery 136 (7) pp 765-772

[20] Canadian Association of Wound Care Prevention and Treatment of Diabetic Foot Ulcers Authors: Inlow S., Orsted H., Sibbald R.G. Ostomy/Wound Management (2000); 46:11, pp55-68

[21] Collier M., Nursing Standard 10:43, 1996, pp 47-53 The Principles of Optimum Wound Management

[22] Krasner D. Wound 8:1, 1996, pp 16-23, Dressing Decisions For The Twenty-First Century

[23] Health Quality Council of Saskatchewan, Saskatchewan Skin and Wound Care Guidelines C:25

[24] Rosser WW, Pennie RA, Pilla NJ and the Anti-infective Review Pannel, Anti-infective Guidelines for Community Acquired Infection Toronto: MUMS Guideline Clearinghouse; 2005

[25] Blondel-Hill E, Fryters S. Bugs and Drugs 2006 Antimicrobial Reference Book, Edmonton, Capital Health Region

[26] Grayson M.L., Gibbons G.W., Balogh K., Levin E., Karchmer A.W., Probing to Bone in Infected Pedal Ulcers, JAMA (273:9), 1995 pp 721-723

[27] Bergstrom N., Bennett M.A., Carlson C.E., et al, 1994 Treatment of Pressure Ulcer Clinical Practice Guideline No. 15 Agency for Health Care Policy and Research

[28] Registered Nurses Association of Ontario (RNAO) Assessment and Management of Foot Ulcers for People with Diabetes, 2005